THE SANDHEADS SAILING DIRECTORY;

OR,

THE SUB-MARINE HOOGHLY DELTA, ITS MARKS AND DEEPS, ITS WINDS, WEATHER, TIDES, AND CURRENTS;

BEING

AN EPITOME OF USEFUL INFORMATION FOR SHIPMASTERS;

ALSO A

HANDY BOOK OF REFERENCE FOR PILOTS.

BY

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"THE BENGAL PILOTS' CODE OF SIGNALS."

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PREFACE.

Having, during my eighteen years' continuous service as a running Pilot on the Hooghly, heard frequent complaints from shipmasters that the works referring to the navigation of the River Hooghly Sandheads, to matters connected with the Pilot Station there, to the Floating Lights, Set of the Tidal and Sea-currents, Winds, and Weather, &c., &c., are all out of date, and in many cases misleading, I determined to take upon myself the no-light-task of writing such a book as should be stored with everything that would be useful to a stranger, whereby he may be almost as much at home at the Sandheads as are the pilots themselves; information about various subjects which constantly crowd upon and perplex the mind of the navigator of these waters, but which the best and most recent works are silent about, or have not dwelt upon sufficiently to make one feel that confidence which one ought to feel in a book of sailing directions; and, more especially, in one referring to such a dangerous corner of the Bay of Bengal, as, I believe one and all agree, the Hooghly Sandheads to be in the S.W. monsoon, and at the transition periods, when cyclones are proved to be so liable to swoop down upon these waters in hurricane gusts.

I have, therefore, spared no pains to search out and put into readable form subject-matter from the best authors; to overhaul and compare my old diaries with the records of the Bengal Meteorological office and the papers published by the gentlemen in charge of that Department; and to give the results of such comparison, and even copies of the diaries themselves; which, I trust, will prove of value to the mariner, whether he be a stranger or not to this north-west corner of the Bay; and make the book not only worthy of a place on every shipmaster's bookshelf, but also a handy book of reference for junior pilots and others.

But, of course, I have not written it with the intention of inducing a shipmaster to try and run his vessel into Saugor without a pilot, but only to put before him a plain picture of the dangers he would have to encounter and how to avoid them, should force of circumstances make it absolutely imperative upon him to run the risk. My advice to all who are caught in bad weather at the Sandheads is to try and buffet it out as do the little pilot brigs, for, "blow high or blow low," they never run, and in fact, for reasons herein set forth, never could run, for that shelter to be found off most ports: and, therefore, a well found ship can always manage to do as well as they do: but, above all, and here comes in the old, old advice—"Make good use of your lead."

Should the arrangement or language of the book not be exactly what it should be, I trust those competent to judge of its subject will not be hard upon me on this account, but will be able to do me the great honor of pronouncing that the work has a deserving claim on the attention of those for whose benefit I have compiled it—my brother sailors.

Looking to the great use their various writings have been to me in the compilation of this book, I beg to draw the attention of all to the no small debt we owe our Indian Meteorologists, Messrs. Blanford and Eliot ; and as a small return and acknowledgment of the benefit they receive from the labours of those two gentlemen, I would suggest that all shipmasters navigating these waters do cheerfully respond to their invitation, and send in, to the address of the Meteorological Reporter to the Government of Bengal, Calcutta, copies of their log-books, giving details of winds and weather (fair or foul) met with whilst coming up the Bay of Bengal, with the corresponding records of the barometer, thermometer, &c., &c., which I feel sure will be very thankfully received.

The bearings are all given as magnetic, which is with three degrees easterly variation from the true north point, and the soundings are given as referring to the Hooghly zero of gauge. The position of the buoys marking the several channels cannot be de-

pended upon for any length of time above the Gasper Channel (351); as, even now, since the following was written, important changes have taken place, and are in progress in the contours and dimensions of the several sands and channels;* but below the Lower Gasper Light (166), the changes are very slow indeed; so that, probably, for years to come the bearings of buoys and other objects from each other will be little altered.

The Index is so arranged that a stranger can, by referring to it, find out easily to what buoy the letters he has seen upon it belong, and thus be enabled to fix his position without much trouble.†

With regard to the colour and beacons of the Light Ships, it is in contemplation to paint their hulls all red: and to so arrange their mast-head beacons, that, without regard to the colour of their beacons, each one will be easily recognizable at a distance: but, of course, due notice to mariners will be given in the usual way, when such alteration from the present state of things, as herein set forth, is made.

The weather, &c., at the Sandheads has been divided into monthly states, but I would advise that the chapter be read as a whole, since there are many

* See Chart, "Saugor Roads and Gasper Channels" (Frontispiece).

† It must not be forgotten that both the Palmyras Reef Buoy and the Pilot's Ridge Buoy, though differently painted, are both marked P R.

things in one month which are intimately connected with another.

Also, as information from various authorities regarding the currents of the Bay is scattered throughout the book, which may be of use for other purposes than for which they are quoted, the reader should look through the whole book.

And with regard to the meteorology of the Bay of Bengal and India, I would recommend all who really wish to know what aerial meteorology means, to possess themselves of Mr. H. F. Blanford's book—"The Indian Meteorologist's Vade Mecum."

All references in the text are to paragraphs, and not to pages.

S. R. E.

CALCUTTA,
September, 1881.

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MAPS.

ERRATA.

Page 11, para. 45, line 22, *for* 'N. 78°,' *read* 'S. 78°.'
,, 91 ,, 312 ,, 2 of foot-note, *for* '1887,' *read* '1881.'
,, 110 ,, 333 ,, 9, *for* 'E. by S.,' *read* 'W. by S.'
,, ,, ,, ,, ,, 12, *for* 'N. W.,' *read* 'N. E.'
,, 113 ,, 333 ,, 2, *for* 'Rhumrah,' *read* 'Dhumrah.'
,, 132 ,, 349 ,, 10, *for* "a,—ll,' *read* ',—all.'
,, 155 ,, 360 ,, 6 & 7 from bottom, *for* '88°,' *read* '89°.'
,, 160 ,, 361 ,, 2, *omit* 'not.'
,, 179 ,, 363 ,, 6, *for* '19°' *read* '91°'
,, 200 ,, 366 ,, 25, *for* 'instead of at the hours,' *read* 'besides at the half hours'
,, 216 ,, 371 ,, 8, *for* 'of the 19 North,' *read* 'of 19° north.'
,, 290 ,, 393 ,, 11 from bottom, *add* 'answering,' *after* 'Preparative.'

THE SANDHEADS
SAILING DIRECTORY.

All Bearings, Magnetic. Var. 2° 45′ E.

1. **The Hidgilee Flat Buoy.** A fifth class buoy without spire, and painted black (an eastern buoy for entering Hidgilee Creek), marked H. F. in white letters. Marks the western limit of Cowcolly Roads, and S. E. extremity of the Flat.

2. From Hidgilee Flat Buoy to Dariapore G. T. S. Bungalow, N. 65° 20′ W., distance 2,980 yards. From 2 fathoms at the H. F. Buoy, gradually shoals across the Hidgilee Flat to dry land at half way; thence over land to the bungalow.

3. From Hidgilee Flat Buoy to the A Buoy (10), S. 38° 37′ E., distance 4,200 yards. From 2 fathoms at the H. F. Buoy, deepens to 3¼ fathoms, and then shoals on the northern extremity of the Eagle Sand, or eastern prong of the Eastern Brace (335), to 2¼ fathoms at two-thirds the distance: then deepens again to 2½ fathoms at the A Buoy, on the western side of the Western Channel (343).

4. From Hidgilee Flat Buoy to Brace Head Buoy (6) (since removed), S. 47° 30′ W., distance 5,900 yards. From 2 fathoms at the H. F. Buoy, deepens to 2½ fathoms, till one-third the distance; then shoals on the Brace Head to half a fathom at the A Buoy.

5. **The Mizen Buoy.** A white buoy marked M. in black, laid on the eastern edge of the northern division of the Mizen Sand in 18 feet, marking the western limits of

the channel running down S.W. from L. West A Buoy, and bears from Dariapore G. T. S. Bungalow E. by S. ⅞ S., 32,000 feet, from A Buoy N. E. by E. ½ E., 10,600 feet, and from B Buoy N. E. by N. ¾ N., 14,500 feet. At three-fifths the distance from A Buoy to this, there is only 13 feet, on the extension of the sand this buoy marks; but deepens gradually on each side of it. There is 22 feet to the westward of the tail of this sand between it and Hidgilee Flat. From 8 feet at B Buoy the line runs up along the eastern edge of the Mizen Sand and deepens to 18 feet at one-third the distance, to 24 feet at three-fourths, and shoals to 18 feet at the M. Buoy.

6. **The Brace Head Buoy** (lately removed) was on the head of the Eastern Brace (335), and on the northern point of a dry prong or patch running down the centre of the Brace in half a fathom. The soundings are constantly varying about here.

7. From Brace Head Buoy to Dariapore Bungalow, N. 8° 40′ W., distance 6,500 yards. From half a fathom at the B. H. Buoy, shoals on mud flats till it meets dry land at one-fourth the distance.

8. From Brace Head Buoy to Hidgilee Flat Buoy (1) N. 47° 30′ E., distance 5,900 yards. Deepens from half a fathom at the B. H. Buoy to 1; then at two-thirds the distance to 2½ fathoms: then shoals to 2 fathoms on the S. E. spit of Hidgilee Flat, at the H. F. Buoy, on the western side of Cowcolly Roads, and just off the edge of the Hidgilee Flat.

9. From Brace Head Buoy to A Buoy (10), N. 84° 40′ E., distance 6,950 yards. From half a fathom at B. H. Buoy, deepens off the Brace to 2 fathoms at one-third the distance, then to 3½ fathoms, shoaling again on the Eagle Sand (339) to 2 fathoms, and deepening again into the Western Channel (343) to A Buoy in 3¼ fathoms on the western side of the Western Channel; the centre part of the Eagle Sand is at three-fourths of the whole distance across between the two buoys.

10. **The A Buoy.** Second class, wood, white with black apex and a red open basket beacon, and marked with a black A. In $3\frac{1}{4}$ fathoms on the eastern edge of the Eagle Sand (339), and marks the western limits of the Western Channel (343). The sand, the northern end of which this buoy marks, runs down in a S.S.W. direction, and joins the Brace at the G Buoy. This buoy also marks the junction of the Western Channel with Cowcolly Roads. This channel was called the Eagle Channel formerly when vessels had to use it, as one of the main ship channels.

11. From the A Buoy to Hidgilee Flat Buoy (1), N. 38° 37′ W., distance 4,200 yards. Shoals gradually right across from $3\frac{1}{4}$ fathoms at the A Buoy to 2 fathoms at the H. F. Buoy, just clearing the northern end of the Eagle Sand (339) at one-third the distance.

12. **The B Buoy.** Second class, iron, black with white apex and black triangular beacon, and marked B in white. In $3\frac{1}{4}$ fathoms on the western edge of the Mizen Sand (340). Marks the extreme limits of the Western Channel (343).

13. From B Buoy to Brace Head Buoy (6), N. 77° 15′ W., distance 7,200 yards. Crosses the Western Channel (343) in $3\frac{1}{2}$ fathoms, and shoals at two-thirds the distance to 2 fathoms on the Eagle Sand (339); then deepens in the gut to the westward of this latter sand to 3 fathoms at half the distance: and at three-fourths the distance shoals to 2 fathoms on the Eastern Brace Head (335), and continues shoaling to half a fathom at the B. H. Buoy (since removed).

14. From B Buoy to A Buoy (9), N. 0° 30′ W., distance 2,200 yards. Crosses diagonally the Western Channel (343) in $3\frac{1}{4}$ fathoms.

15. **The C Buoy** (since removed). Second class white, with black apex and red open-worked basket beacon, marked C in black. In $2\frac{1}{2}$ fathoms on the eastern edge of the Eagle Sand (339) (which runs here N.N.E. & S.S.W.), and marks the extreme western limits of the Western Channel (343).

16. From the C Buoy to the B. H. Buoy (since removed) (6), N. 52° 45′ W., distance 5,950 yards. From 2½ fathoms at the C Buoy, crosses the Eagle Sand (339) in 1¾ fathoms, deepening into 3 fathoms beyond it at one-fourth the distance, gradually shoaling to 2 fathoms on the edge of the Eastern Brace Head (335); then to half a fathom at the B. H. Buoy on the head of a dry long patch.

17. From C Buoy to B Buoy (31), N. 50° 45′ E., distance 3,000 yards. Crosses the Western Channel diagonally in 3¾ fathoms, the deepest at two-thirds the distance from C to B Buoy on the eastern side of the Western Channel (343), and off the western edge of the Mizen Sand (340).

18. **The Centre Saugor Flat Buoy.** In 40 feet, on the western edge of Saugor Flat (347), and marks the extreme eastern limit of the lower part of Bedford's Channel. (A good sheltered anchorage is found for 2 miles above this buoy.) Black with black ball beacon, marked C. S. F. in white. The channel runs N.N.E. & S.S.W. here, and up as far as Black point: so that, with a strong S. W. monsoon and strong tides vessels do not lay at anchor very quietly (remembering that the mean direction of the wind is S.S.W. in the S.W. Monsoon), but it is a good place for anchoring in threatening weather, or when there is a probability of a cyclone. There is no Upper Saugor Flat Buoy.

19. From Centre Saugor Flat Buoy to C Buoy (since removed) (15), N. 85° 00′ W., distance 11,900 yards. Gradually shoals from 40 feet at the C. S. F. Buoy across the upper part of Saugor Roads (397) to 4¼ fathoms on the tail or apex of Bedford's Sand at one-fifth the distance; then deepens across the entrance to the Eden Channel, or rather junction of that channel with Saugor Roads (349), to 5 fathoms on the edge of the Mizen Sand (340) at two-fifths the distance; crosses the dry centre of the Mizen Sand at three-fourths the distance, and deepens off the Mizen Sand to 3¼ fathoms on the eastern side of the Western Channel, and then to 4 fathoms across the channel, shoaling again

to $2\frac{1}{2}$ fathoms at the C Buoy on the western side of the Western Channel (343).

20. From Centre Saugor Flat Buoy to B Buoy (12), N. 72° 15′ W., distance 9,990 yards. Shoals from 40 feet at C. S. F. Buoy to $3\frac{1}{4}$ fathoms to the northward of the Apex Buoy (35) (it will now be to the southward of that buoy as it has been shifted 900 yards N.N.E.), deepens in the lower part of Eden Channel to $4\frac{1}{2}$ fathoms; then shoals gradually to 4 fathoms on the eastern edge of the Mizen Sand (340) at half the distance, then suddenly to 2, and so on at two-thirds the distance strikes the dry Mizen; afterwards deepens off it to $3\frac{1}{4}$ fathoms at the B Buoy on eastern side of the Western Channel (343).

21. From Centre Saugor Flat Buoy to A Buoy (10), N. 61° 00′ W., distance 10,950 yards. Shoals gradually from 40 feet at the C. S. F. Buoy across the channel to $2\frac{3}{4}$ on the apex of Bedford's Sand at one-fourth the distance; deepens to $5\frac{1}{2}$ fathoms in the lower part of the Eden Channel, and shoals suddenly from 4 to 2 on the Mizen Sand (340) at three-fifths the distance; then crosses the dry Mizen Sand and deepens off it into the Western Channel (343) to 3 fathoms at 300 yards (the width of the Western Channel here) from the A Buoy on the western side of the Western Channel (343), crossing it in $3\frac{1}{4}$ fathoms.

22. **The D Buoy.** Second class, iron, black with white apex and black triangular beacon, marked D in white. In $3\frac{1}{2}$ fathoms on the western edge of the tail of the Mizen Sand (340). Marks the extreme eastern limits of the Western Channel (343). Sand steep to, to the eastward and abreast of this buoy.

23. From D Buoy to Eastern Brace Fairway Buoy (31), N. 86° 50′ W., distance 10,700 yards. From $3\frac{1}{2}$ fathoms at the D Buoy, shoals across the Western Channel (343) to $2\frac{1}{2}$ when in a line of the western buoys; then rapidly to $1\frac{1}{2}$ fathom on the Eagle Sand (339) at one-fourth the distance; deepens again to 3 fathoms in the gut between the Eagle Sand and Eastern Brace Head (335), shoaling again at half

the distance to 2 fathoms on edge of Eastern Brace, and crosses the dry patch in its centre at four-fifths the distance; then deepens to 2 fathoms at the E. B. F. Buoy at the gut which separates the Eastern and Western Braces.

24. From D Buoy to Brace Head Buoy (since removed) (6), N. 37° 30′ W., distance 8,400 yards. From $3\frac{1}{2}$ fathoms at D Buoy, gradually shoals diagonally across the Western Channel (343) to 2 fathoms on the edge of the Eagle Sand (330), then to $1\frac{3}{4}$ fathoms on its centre at two-fifths the distance: deepens off it at half the distance to 2 fathoms and then to 3 fathoms in the gut or channel at the back of the Eagle Sand, and shoals to 2 fathoms at four-fifths the distance on the Eastern Brace Head (335), then to three-fourths of a fathom at the head of a dry patch, where the buoy was placed.

25. From D Buoy to C Buoy (since removed), N. 19° 30′ W., distance 3,150 yards. From $3\frac{1}{2}$ fathoms at D Buoy, gradually shoals diagonally across the Western Channel (343) to $2\frac{1}{2}$ fathoms at C Buoy (since removed) on the western side of the Western Channel.

26. From D Buoy to B Buoy (12), N. 20° 00′ E., distance 5,380 yards. From $3\frac{1}{2}$ fathoms at D Buoy, shoals to 3 fathoms at half the distance as it skirts the western edge of the Mizen Sand (340), and deepens again to $3\frac{1}{4}$ fathoms at the B Buoy. This line marks the eastern limits of the Western Channel (343).

27. From D Buoy to Centre Saugor Flat Buoy (18), N. 80° 00′ E., distance 11,500 yards. From $3\frac{1}{2}$ fathoms at D Buoy, shoals immediately to 2 fathoms on the western edge of the Mizen Sand (340), then meets the edge of dry sand at half a mile, which it has crossed at one-fourth the distance, then deepens to $2\frac{3}{4}$ at the head of the gut running up N.N.E. between the Mizen and Long Sands (341), and strikes across the head of the Long Sand in a 12-foot channel through which the ebb sets strong, especially at the last half or quarter ebb: and deepens from 3 fathoms on the edge of the Long Sand to 5 fathoms as it passes to north

of the L. L. Buoy (41) at three-fourths the distance, and shoals to 4 fathoms to south of Apex Buoy, and then deepens to 40 feet at C. S. F. Buoy.

28. From D Buoy to Apex Buoy (36), N. 86° 00′ E., distance 8,950 yards. From $3\frac{1}{2}$ fathoms at D Buoy, shoals immediately to 2 fathoms on the western edge of the Mizen Sand (340); then meets the edge of dry sand at half a mile which it has crossed at two-fifths the distance; then deepens to $2\frac{3}{4}$ fathoms at the head of the gut* running up N.N.E. between the Mizen and Long Sands (341), and strikes across the head of the Long Sand in a 12-foot channel through which the ebb sets strong, more especially on the last half or quarter ebb, and deepens from 3 fathoms on the edge of the Long Sand to $4\frac{3}{4}$ fathoms as it passes close to north-west of L. L. Buoy at fourth-fifths the distance, shoals to 23 feet at the Apex Buoy, which has been since shifted N.N.E., 900 yards.

29. From River Surveyor's Report of 29th July, 1880.

"The three buoys on the Balasore Bar have been laid in a very good position.

"Two nun buoys have been laid between the Eastern, and Western Braces in about 1 fathom, reduced in the following position: The Western Buoy; Eastern Brace Fairway Buoy, N.N.E.; Sola Buoy, S. W.; the Eastern Buoy, in about $1\frac{1}{2}$ fathoms reduced, but no bearings could be taken as the rollers were too high."

30. **Eastern Brace Fairway Buoy.** A fourth class wooden buoy, painted black and white in vertical sections, and marked E. B. F. in black, and surmounted with a red open basket beacon. In 2 fathoms to the westward of a dry patch running N.N.E. and S.S.W. up the Eastern Brace (335), and at the head of a narrow 2-fathom gut between it and the Flat off Sand Hill Mark, a mark or beacon erected on dry land $1\frac{1}{2}$ miles N.N.W. of this buoy.

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* This gut has since almost closed.

31. From Eastern Brace Fairway Buoy to Dariapore, N. 20° 00′ E., distance 13,250 yards. From 2 fathoms at the E. B. F. Buoy, shoals to half a fathom on the 2-mile bar connecting the Eastern Brace Head (335) with the land, until at one-third the distance, where it reaches low water mark: then over dry land to the bungalow of Dariapore.

32. From Eastern Brace Fairway Buoy to Brace Head Buoy (since removed) (6), N. 42° 40′ E., distance 8,200 yards. Shoals immediately from 2 fathoms at the E. B. F. Buoy to half a fathom at half the distance on the bar (whose length this line measures) on the western edge of the long dry patch of sand on the Eastern Brace Head (335), deepening to three-quarters of a fathom at the B. H. Buoy (since removed).

33. From Eastern Brace Fairway Buoy to B Buoy (12), N. 70° 30′ E., distance 13,280 yards. Shoals on the bar as the last line, then crosses the centre of dry patch at one-fifth the distance; deepens off the bar connecting the Eastern Brace Head (335) with the land into 2 to 2½ fathoms at half the distance: and to 3¼ in the gut between Eastern Brace Head and Eagle Sand (339) at three-fifths the distance, then shoals on the Eagle Sand to 2 fathoms at three-fourths the distance; deepens to 3½ fathoms as it crosses the Western Channel (343), and ends in 3¼ fathoms at the B Buoy on its eastern side.

34. From Eastern Brace Fairway Buoy to C Buoy (since removed), (15), N. 76° 15′ E., distance 10,460 yards. Crosses nearly the same as the last line, excepting that it does not cross the Western Channel (343), the C Buoy having been a western buoy for the channel when it was in position.

35. **The Apex Buoy of Bedford's Channel.** A second class wooden buoy, painted red and black in vertical sections, marked A P E X in white, and surmounted with a red basket and black triangular beacon in 23 feet. On the tail of Bedford's Sand, marks the eastern limit of Eden Channel and junction of Eden Chan-

nel and upper part of Saugor Roadstead (349). A deep water gut runs up N.N.E. to the eastward of this buoy, which is very useful as a haven of refuge in cyclones; see sec. 19. This buoy has since been moved 900 yards N.N.E.

36. From Apex Buoy to C Buoy (since removed) (15), N. 75° 15′ W., distance 9,720 yards. From 23 feet at Apex Buoy, deepens across the entrance to the Eden Channel to 5 fathoms close to the edge of junction of Mizen Sand (340) with the head of the Long Sand (341) at one-fourth the distance; then shoals somewhat suddenly on to the sand till the eastern edge of central dry patch of the Mizen is reached at half the distance, deepening again off dry patch at three-fourths the distance to 1 fathom and to 3 fathoms off the western edge of the Mizen at 1 mile from the C Buoy (the width of the Western Channel here), then to 4 fathoms, and shoaling gradually across the Western Channel to the C Buoy in 2½ fathoms on the edge of the Eagle Sand (339).

37. From Apex Buoy to B Buoy (12), N. 58° 00′ W., distance 8,340 yards. Deepens from 23 feet at Apex Buoy diagonally across the entrance to the Eden Channel to 4½ fathoms near the eastern edge of the Mizen Sand (340) at one-third the distance. Then shoals suddenly into 1 fathom, and strikes the dry centre of the Mizen at three-fourths the distance; deepens off the dry patch at a quarter of a mile S.E. of the buoy, gradually deepening to 3¼ fathoms at the B Buoy on the eastern side of the Western Channel (343).

38. From Apex Buoy to A Buoy (10), N. 46° 45′ W., distance 6,750 yards. From 23 feet at Apex Buoy, deepens to 4¾ fathoms as it strikes diagonally across the entrance to the Eden Channel; shoals to 4 fathoms on the extreme western limits of the channel, and shoals suddenly on the eastern edge of the Mizen Sand (340) to 1 fathom at one-third the distance; then strikes the dry patch at two-fifths the distance, crosses it and deepens again to 1 fathom at three-quarters of a mile from the A Buoy and to 3 fathoms off the western edge of the Mizen Sand half a mile from it,

deepening to 3¼ fathoms at the A Buoy, which should be a mark for the western limits of the Western Channel (343) and head of Eagle Sand (339), but which is, in this triangulation, some distance to the eastward of the Eagle Sand.

39. From Apex Buoy to Lower Western Bedford's Buoy, N.N.E. 3½ miles. Carries about 3½ fathoms right up along the eastern edge of the Bedford Sand, marking the extreme western limits of the excellent gut or haven of refuge, running up between this line and Saugor Flat (347) to the northward of Black Point Mark (the first landmark above Saugor Lighthouse (54), erected right abreast the L. B. Buoy, now under discussion, where the channel is nearly a mile broad).

40. From Apex Buoy to Centre Saugor Flat Buoy (18), N. 60° 48′ E., distance 2,800 yards. Deepens gradually from 23 feet at Apex Buoy across the old entrance to Bedford's Channel and the excellent gut just spoken of, to 7 fathoms close to it and to 40 feet at the C. S. F. Buoy, which lies close to the steep western edge of Saugor Flat (347).

41. **The Lower Lloyd's Buoy** (the only remaining buoy of the old Lloyd's Channel, which led from Saugor Roads (349) to Cowcolly Roads). A second class wooden buoy, painted red with red open basket beacon, marked L. L. in white. Marks the extreme western limits of the northern part of Saugor Roads, and is in 21 feet on the eastern edge of the head of the Long Sand (341). The last of the ebb-tide sets S.W. strong through the 2¼ fathoms channel,* which separates the Long Sand from the Mizen Sand (340) near this buoy.

42. From Lower Lloyd's Buoy to D Buoy (22), N. 84° 15′ W., distance 6,700 yards. From 21 feet at L. L. Buoy, shoals on the junction of Long Sand (341) with the Mizen (340) to 2½ fathoms; then deepens to 3 fathoms on the western side of it, shoaling to 1 fathom on the eastern edge

* This gut appears to have since nearly closed up.

of the Mizen Sand at half the distance, in the centre of dry patch at three-fourths the distance; deepens off the western edge of the Mizen to 3 fathoms close to it and to 3½ fathoms at the D Buoy on the eastern side of the Western Channel (343).

43. From Lower Lloyd's Buoy to B Buoy (12), N. 40′ 00′ W., distance 7,500 yards. From 21 feet at the L. L. Buoy, shoals on the Mizen Sand (340) close to it to 2 fathoms, and then gradually shoals till the dry patch of sand is reached at half the distance (which is three-quarters of a mile broad on this line); deepens off it at half a mile from the B Buoy to 1 fathom, and then off the Mizen Sand to 3¼ fathoms at the last named buoy on the eastern side of the Western Channel (343).

44. From Lower Lloyd's Buoy to Apex Buoy (36), N. 60° 40′ E., distance 2,550 yards. Deepens from 3½ fathoms at L. L. Buoy to 4¼ fathoms half way, shoaling again as it runs across the junction of Saugor Roads (349) and the Eden Channel to 23 feet at the Apex Buoy on the eastern side of the Eden Channel.

45. From Lower Lloyd's Buoy to Lower Saugor Flat Buoy (51), N. 78° 15′ E., distance 3,880 yards. Deepens from 3½ fathoms at the L. L. Buoy to 4 fathoms half way; then a cast of 4¼ fathoms, deepening again to 6¾ fathoms close to the L. S. F. Buoy and to 37 feet at it on the eastern side of Saugor Roads (349).

46. **The E Buoy.** A second class iron buoy, painted white with black apex, surmounted with red open basket beacon, and marked with an E in black. In 14 feet on the western limits of the Western Channel (343), and on the eastern edge of the Eagle Sand (339).

47. From E Buoy to Eastern Brace Fairway Buoy (30), N. 72° 45′ W., distance 9,100 yards. From 14 feet at the E Buoy, shoals on the Eagle Sand (339) to half a fathom on its centre at half a mile distance; then it deepens again off the western edge of this sand into the gut running down S.S.W. to 2 fathoms at one-fifth the distance, and then to 3

fathoms, shoaling again to 2 fathoms on the eastern edge of the Eastern Brace Head (335) at half the distance; strikes the long dry patch of sand running down S.S.W. at three-fifths the distance, deepens off it half a mile from the E. B. F. Buoy, and gradually deepens to 2 fathoms at this buoy at the extreme head of the gut which separates the two Braces, and which runs up in about a N.N.E. direction.

48. From E Buoy to Brace Head Buoy (since removed) (6), N. 19° 45′ W., distance 9,280 yards. From 14 feet at the E Buoy, shoals on the Eagle Sand (339) to three-quarters of a fathom at three-quarters of a mile distance; deepens off the Eagle Sand into 2 fathoms at one-fourth the distance, then to 3 fathoms, and gradually shoals, as it strikes diagonally across the gut running down from Cowcolly Roads in a S.S.W. direction, to 2 fathoms on the eastern edge of the Eastern Brace Head (335) at three-fourths the distance, gradually shoaling to three-fourths of a fathom at the spot where the buoy was laid on the extreme N.N.E. end of the long dry patch which the last line given crossed lower down.

49. From E Buoy to D Buoy (22), N. 44° 30′ E., distance 2,850 yards. From 14 feet at the E Buoy, gradually deepens to 3½ fathoms at the D Buoy as it runs diagonally across the Western Channel (343).

50. From E Buoy to Lower Lloyd's Buoy (41), N. 80° 30′ E., distance 8,800 yards. From 14 feet at the E Buoy, gradually deepens across the Western Channel (343) to 3¼ fathoms on the steep western edge of the tail of the Mizen Sand (340) at one-eighth the distance; strikes the dry centre of this sand at a quarter the distance, deepens in the gut to the eastward of it to 2 fathoms at half the distance, then to 2½, and carries not less than 13 feet across the head of the Long Sand (341). But this last is not to be depended upon as being constant.*

* Since these lines were written, this spot has shoaled considerably, 1881.

51. **The Lower Saugor Flat Buoy.** Black, second class, iron, marked L. S. F. in white, and surmounted with a black ball beacon. Marks the extreme eastern limits of Saugor Roads (349) and the south-western prong or extremity of Saugor Flat (347). Is moored in 37 feet. Between this buoy and the Upper Middleton Buoy deep water stretches well into Saugor Beach. Since this triangulation, this buoy has been moved 1,400 yards N. by W.

52. From Lower Saugor Flat Buoy to Lower Lloyd's Buoy (41), N. 78° 15′ W., distance 3,880 yards. From 37 feet at the L. S. F. Buoy, shoals gradually as it strikes diagonally across Saugor Roads (349) to 3½ fathoms at the L. L. Buoy.

53. From Lower Saugor Flat Buoy to Apex Buoy (36), N. 36° 45′ W., distance 2,600 yards. Shoals gradually from 7 fathoms near the L. S. F. Buoy to 23 feet at the Apex Buoy as it crosses the entrance to the old Bedford's Channel and gut of good-anchorage above. Since this triangulation was made, the Apex Buoy has been shifted 900 yards N.N.E. into 22 feet.

54. **Saugor Lighthouse.** Half mile inland on the western side of the south end (Middleton Point) of Saugor Island (350); in Lat. 21° 38′ 43″ N., Long. 88° 2′ 00″ E.; height 74 feet above sea-level. Visible at 16½ miles; oscilates through an arc of 225 degrees, or from (as seen from vessel) N.W. round by N. and E. to south, in 20 seconds. Painted with three red bands and three white bands alternately, the top band being red. Is a reporting station for shipping, and has electric communication with Calcutta and the intermediate stations—at Mud Point, Diamond Harbour, Hooghly Point, and Atcheepore; storm-signals are also hoisted here on the approach of cyclones, &c. Persons cast away on the southern side of Saugor Island should not attempt to make their way strait for the Lighthouse, as the jungle is impenetrable and infested with tigers, but should follow the coast line round as well as able. High water abreast Saugor Lighthouse on F. & C. days, 10h. 00m. Rise of tide-springs 15 feet; neaps 11 feet.

55. From Saugor Lighthouse to Lower Saugor Flat Buoy (51), N. 63° 15′ W., distance 4,110 yards. Strikes the sea at about one-third the distance to the northward of the mouth of the creek, but does not deepen off Saugor Flat (347) until at half the distance, when there is suddenly 6½ fathoms, shoaling to 5 fathoms, not far from the L. S. F. Buoy, and deepening again to 37 feet at it, on the S.W. spur of Saugor Flat and on the eastern side of Saugor Roads (349).

56. From Saugor Lighthouse to Apex Buoy (35), N. 53° 15′ W., distance 6,650 yards. Strikes the sea at one-fourth the distance, but does not deepen off Saugor Flat (347) till at three-fifths the distance; deepening off it suddenly from 2½ fathoms into 7 and 8 fathoms at four-fifths the distance, shoaling again to 23 feet at the Apex Buoy. This buoy has since been shifted 900 yards N.N.E.

57. From Saugor Lighthouse to the Centre Saugor Flat Buoy (8), N. 28° 15′ W., distance 6,050 yards. Strikes the sea at one-third the distance, and for the remainder crosses Saugor Flat (347) in small water, until suddenly deepening to 40 feet at the C. S. F. Buoy.

58. **The Upper Middleton Buoy.*** A second class iron buoy, painted black and marked U. M. in white. On the northern end of the spit of the Middleton Sand (348); marks the extreme eastern limits of Saugor Roads (349), and lies in 29 feet at present (1880), but was first laid to mark the centre of a 15-foot patch on which the S. S. "City of Carthage" grounded. Abreast of this buoy there is deep water—6, 5, and 4 fathoms close in to Saugor Beach and for some distance down to the southward between the spit of the Middleton and Saugor Island (350): but there is only 2½ fathoms a short distance down the spit from the buoy in a S.S.E. direction.

59. From Upper Middleton Buoy* to E Buoy (46),

* Since the above was written, this buoy has been moved S. by E. ¼ E., 2,050 yards.

N. 77° 00′ W., distance 12,980 yards. From 29 feet at the U. M. Buoy deepens to $5\frac{3}{4}$ fathoms as it crosses Saugor Roads (349) and shoals on the Long Sand (341) to 2 fathoms at one-fourth the distance, and to half a fathom on the centre of the Long Sand at half the distance; deepens again at two-thirds the distance to 2 fathoms on the western edge of the Long Sand and to $2\frac{1}{4}$ in the gut running up N.N.E. between the Long Sand and tail of the Mizen Sand (340); shoaling again on the edge of the Mizen Sand (at three-fourths the distance), crosses the dry patch of the Mizen and deepens to 2 fathoms on its western edge 1 mile to eastward of the E Buoy, then to $3\frac{1}{4}$ in the Western Channel, gradually shoaling as it crosses this channel to 14 feet at the E Buoy at the edge of the Eagle Sand (339).

60. From Upper Middleton Buoy* to D Buoy (22), N. 65° 00′ W., distance 11,750 yards. From 29 feet at the U. M. Buoy, gradually deepens to 6 fathoms as it crosses Saugor Roads (349) diagonally, and as it approaches the Long Sand (341), shoaling till in 4 fathoms on its eastern edge at one-third the distance; carries 12 feet across till the eastern edge of the tail of the Mizen Sand (340) is reached in 1 fathom at three-fourths the distance; then shoals and crosses the dry patch, deepening again off the Mizen Sand from 1 into 3 fathoms close to the D Buoy, and to $3\frac{1}{2}$ fathoms at it: this line crosses the Long Sand about midway of L. L. S. Buoy and L. L. Buoy (85 and 41).

61. From Upper Middleton Buoy* to Lower Saugor Flat Buoy (51), N. 21° 00′ E., about $1\frac{3}{8}$ miles. Deepens from 29 feet at U. M. Buoy to 6 fathoms as the L. S. F. Buoy is neared, then to 37 feet at this buoy. This last line is of late date, or since the L. S. F. Buoy has been moved from where it was formerly.

62. From Upper Middleton Buoy to Saugor Light-

* Since the above was written, this buoy has been moved S. by E. $\frac{1}{4}$ E., 2,950 yards.

house (54), N. 66° 15′ E., distance 3,950 yards. Gradually deepens from 29 feet at the U. M. Buoy to 6 fathoms, a short distance from the beach, at three-fifths the distance, then shoals on the beach, and thence over land.

63. **The F Buoy** (since removed) was an eastern buoy, painted black with white apex, and surmounted with black triangular beacon, and marked with an F in white. On the edge of the tail of the Mizen Sand in 2½ fathoms, marked the extreme eastern limits of the Western Channel (343).

64. From F Buoy to Eastern Brace Fairway Buoy (30), N. 53° 30′ W., distance 11,550 yards. From 2½ fathoms at the F Buoy, deepens across the Western Channel (343) till in 2¾ fathoms, then shoals to 2 fathoms on the eastern edge of the Eagle Sand (339) at one-fifth the distance; shoals to half fathom on this sand, and deepens again in the gut running down S.S.W. between the Eagle Sand and Eastern Brace Head (335) at half the distance; shoals on the Eastern Brace Head to 2 fathoms at three-fourths the distance, crosses the dry patch running down S.S.W. on the Eastern Brace Head, and deepens off it half a mile from the E. B. F. Buoy till in 2 fathoms at its position in the extreme northern end or head of the narrow gut which runs up N.N.E. (here) between the Western Brace Head and the Eastern Brace.

65. From F Buoy to E Buoy (46), N. 8° 15′ W., distance 4,220 yards. After leaving the 2½ fathoms at the F Buoy, carries 2¾ fathoms the whole way as it strikes diagonally up and across the Western Channel (343), till it falls into 2½ again at the E Buoy on the western side of the Western Channel.

66. From F Buoy to D Buoy (22), N. 12° 30′ E., distance 6,400 yards. From 2½ fathoms at the F Buoy, gradually deepens to 3 at one-third the distance, and to 3½ fathoms as it runs to the northward along the western edge of the tail of the Mizen Sand (340), continuing in 3½ fathoms to the D Buoy. This line is the extreme eastern limit of the Western Channel (343).

67. From F Buoy to Lower Lloyd's Buoy (41), N. 55° 00′ E., distance 9,800 yards. From 2½ fathoms at the F Buoy, shoals immediately on the very tail of the Mizen Sand (340) into 1½ fathoms at half a mile; deepens into the gut running up N.N.E. between the Long Sand (341) and the tail of the Mizen into 3 fathoms just before striking the western edge of the Long Sand at one-third the distance; shoals to about 12 feet on the Long Sand, and deepens into 2¾ fathoms a quarter of a mile from the L. L. Buoy, and to 21 feet at it on the western side of the upper part of Saugor Roads (349). The last quarter ebb seems to set strong down this line from L. L. Buoy.

68. **The G Buoy.** A second class wooden buoy, painted white with black apex, surmounted with a red open basket beacon, and marked with a G in black. Lies in 13 feet on the eastern edge of the Eastern Brace, and marks the extreme western limits of the Western Channel (343).

69. From G Buoy to Eastern Brace Fairway Buoy (30), N. 32° 45′ W., distance 11,700 yards. Shoals from 13 feet at the G Buoy to 1 fathom at half the distance about the centre of the Eastern Brace (335). Then strikes the tail of the 5-mile dry patch running N.N.E. & S.S.W. at three-fourths the distance, and deepens again to 2 fathoms at the E. B. F. Buoy at the very head of the narrow gut which separates the Eastern Brace from the Western Brace Head (331).

70. From G Buoy to F Buoy (63), N. 44° 00′ E. distance 4,000 yards. From 13 feet at the G Buoy on the edge of the Eastern Brace (335), deepens to 2¾ fathoms as it strikes diagonally up across the Western Channel (343), shoaling again to 2½ fathoms at the F Buoy on the edge of the tail of the Mizen Sand (340).

71. **The Sola Buoy.** A second class iron buoy, painted black with a black ball beacon. In 3 fathoms on the western edge of the Eastern Brace (335), and on the

eastern side of the channel or gut, which running up here N.E. by N. separates the Eastern Brace from the Western Brace Head (331), and is marked with an S. in white.

72. From Sola Buoy to the nearest part of Balasore Beach, W.N.W., 4½ miles. From 2¾ fathoms at the S. Buoy, shoals across the gut, separating the two Braces to 2 fathoms on the eastern edge of the Western Brace (331) at one-third the distance; then to a quarter of a fathom at the very tail end of a dry tongue of sand running down in a S.W. direction from Sand Hill Mark, 6¾ miles off. It then deepens off the western edge of the Western Brace to 2¼ fathoms at the extreme northern end of the gut running up from the water of Balasore (332) between the Western Brace Head thus far and the land at four-fifths the distance; then shoals and strikes the land. From this point the coast line curves away from S.W. above it to W.S.W., whilst the Western Brace curves round from S.W. to the left just as rapidly.

73. From Sola Buoy to Eastern Brace Fairway Buoy, N. 30° 00′ E., distance 11,800 yards. From 2¾ fathoms at the Sola Buoy gradually shoals as it runs up along the western edge of the Eastern Brace till it reaches the E. B. F. Buoy at the head of the gut in 2 fathoms.

74. From Sola Buoy to E Buoy (46), N. 60° 15′ E., distance 15,950 yards. From 2¾ fathoms at the S. Buoy, gradually shoals on the Eastern Brace (335) to half a fathom at two-fifths the distance just off the northern edge of a 2-mile narrow dry patch running up the Brace about N. by E., then gradually deepens across the Eastern Brace to 2½ fathoms on its eastern edge at two-thirds the distance, and to 3 fathoms as it crosses diagonally the gut to the westward of the Eagle Sand (339), and shoals to 2 fathoms on the western edge of the Eagle Sand at four-fifths the distance, shoaling to half a fathom on this sand, which is here about 1 mile broad, and deepens to 14 feet at the E Buoy on its eastern edge and on the western side of the Western Channel (343). This line passes somewhere near the eastern nun buoy, two of

which have been lately laid to mark the opening between the two dry patches on the Eastern Brace, in which, according to the last chart, there is not less than 1 fathom. See (29).

75. From Sola Buoy to F Buoy (63), N. 75° 30′ E., distance 14,950 yards. From 2¾ fathoms at the S. Buoy, shoals immediately on the Eastern Brace (335), and just to the northward of a small dry patch into half a fathom 1 mile off, then deepens to three-quarters of a fathom, and afterwards strikes across the 2-mile dry patch mentioned in the last line of soundings at two-fifths the distance; deepens off it gradually till into 2½ fathoms just to the S.W. of the bottom of the gut which ends here and which separates the Eagle Sand from the brace in a N.N.E. direction for 8¾ miles, passing the bottom of gut at two-thirds the distance; it then shoals on the junction of Eagle Sand (339) with Eastern Brace to half a fathom; deepens to 2 fathoms on the eastern edge of this sand at 1¼ mile from the F Buoy, crosses the Western Channel (343) in 2¾ fathoms, and shoals to 2¼ fathoms at the buoy on the eastern side of the Western Channel, and on the western side of the tail of the Mizen Sand (340).

76. From Sola Buoy to the G Buoy (68), N. 85° 45′ E., distance 11,760 yards. Shoals immediately on the Eastern Brace (335) from 2¾ fathoms at the S. Buoy to half a fathom half a mile off, just to the northward of a small dry patch; deepens again to three-quarters of a fathom and strikes the centre of the southern or 2-mile dry patch at half the distance; deepens again to 1¾ fathoms and to 2 fathoms on the edge of the Eastern Brace close to the G Buoy, and to 13 feet at it on the western side of the Western Channel (343). By implication, I suspect, as in the last line of soundings, but a short distance to the northward of this one, there must be shoal water close to, to the westward of the eastern edge of the Brace, say half or three-quarters of a fathom.

77. **Dooblat Grove** (in Lat. 21° 36′ 30″ N., Long. 88° 7′ E.), about 1,200 yards from low water mark. On

the south end of Saugor Island, a grove of tall *Casuarina* trees, forming a straight line running E. by N. & W. by S. (are end on from a position between Saugor Anchoring Buoy (93) and Middleton Spit Buoy (80), and are then on with Saugor Point and the mouth of the large creek, whose eastern bank is white sand, but western bank green bushes right down to the water line). This grove is seen in clear weather from 2 miles below the Lower Gasper Light (166), say 12 or 13 miles off, bearing north when on with Lower Gasper Light Vessel.

78. From Dooblat Grove to Upper Middleton Buoy (58), N. 79° 30′ W., distance 10,874 yards. Crosses large creek, then strikes the sea at about half the distance, soon deepens into 3 fathoms; and in the gut at the back of Middleton Spit to 5¼ fathoms at four-fifths the distance; shoaling again to 4 fathoms a short distance to the S.E. of the U. M. Buoy, and to 29 feet at it on the spit of the Middleton Sand (348) and eastern side of Saugor Roads (349).

79. From Dooblat Grove to Saugor Lighthouse (54), N. 68° 00′ W., distance 10,874 yards. Over land overgrown with impenetrable jungle interspersed with creeks.

80. **The Middleton Spit Buoy.*** A second class wooden buoy. In 19 feet. On the western edge of the spit of Middleton Sand (348), which is a spit running up from the Middleton about N.W. for 3,250 yards, and marks the extreme eastern limits of Saugor Roads (349), painted black, marked M. S. in white, and surmounted with a black ball beacon.

81. From Middleton Spit Buoy* to Long Sand Spit Buoy (85), N. 72° 15′ W., distance 3,050 yards. Deepens from 19 feet at the M. S. Buoy to 4¾ fathoms half way; and 5 fathoms at three-fourths the distance, as it crosses Saugor Roads (349), and to 28 feet at the L. S. S. Buoy on the edge of the Long Sand and on the extreme western limits of Saugor Roads.

82. From Middleton Spit Buoy* to Upper Middleton

* This buoy has been since moved 2,000 yards S. by E. ⅜ E.

Buoy (58), N. 17° 00′ W., distance 4,500 yards. In its course up the eastern edge of the Middleton Spit (348) gradually deepens from 19 feet at the M. S. Buoy to 29 feet at the U. M. Buoy. This line marks the extreme eastern limits of Saugor Roads (349); and at 1,300 yards to the eastward of it, at two-thirds the distance along this line, there is only $2\frac{1}{2}$ fathoms, although $4\frac{3}{4}$ fathoms is found in the broad gut between the Spit and Saugor Beach, to the eastward of this line.

83. From Middleton Spit Buoy* to Saugor Lighthouse (54), N. 20° 50′ E., distance 6,400 yards. Shoals from 19 feet at the M. S. Buoy to $2\frac{1}{2}$ fathoms on the spit at one-third the distance on the centre of the spit of Middleton Sand (348); deepens to 4 fathoms off the spit at half the distance, deepens to 5 fathoms, and then to $5\frac{3}{4}$ close to the beach, which on this line may be approached closer than anywhere else, and strikes the beach due east of the U. M. Buoy at three-quarters the distance, thence over land to the Lighthouse.

84. From Middleton Spit Buoy* to Dooblat Grove (77), N. 81° 20′ E., distance 12,520 yards. Shoals from 19 feet to $2\frac{3}{4}$ fathoms immediately on to the spit of the Middleton Sand (348), and carries this depth until well to the eastward of the line of Saugor Lighthouse (54) and the Upper Eastern Gasper Buoy at one-third the distance; shoals to $2\frac{1}{4}$ fathoms at two-fifths the distance and carries about the same water till close into Saugor Beach to the westward of the large creek, striking low water mark at two-thirds the distance, crosses the creek, and thence over land to the Dooblat Grove.

85. **The Long Sand Spit Buoy.** A second class wooden buoy, painted red, marked with L. S. S. in white, and surmounted with a red open basket beacon. In 28 feet on the eastern edge of the Long Sand and on the extreme western limits of Saugor Roads (349). The Long Sand (341) immediately to the westward of this buoy shoals

* This buoy has been since moved 2,000 yards S. by E. $\frac{5}{8}$ E.

very rapidly, and but half a mile off is dry with 10 or 12 feet rise of tide. Anchorage of 5 and $5\frac{1}{4}$ fathoms commences from just to the N.N.E. of this buoy, but only $4\frac{3}{4}$ fathoms below it, to reach which inward vessels must open the Lower Gasper Light well to the eastward of the upper one after Saugor Lighthouse (54) bears N. by E. $\frac{1}{2}$ E.

86. From Long Sand Spit Buoy to F Buoy (63), N. 78° 30′ W., distance 10,650 yards. From 28 feet at the L. S. S. Buoy, shoals suddenly on the eastern edge of the Long Sand (341) to $1\frac{1}{2}$ fathoms and at 1 mile distance is on the centre of patch dry with 10 feet rise; deepens to 2 fathoms at two-thirds the distance, and leaves the western edge of the Long Sand at three-fifths the distance, deepening to 3 fathoms and to $3\frac{1}{2}$ fathoms as it crosses the mouth of the gut running up N.N.E. between the tail of the Mizen Sand (340) and the head of the Long Sand, shoaling to 2 fathoms on the eastern edge of the tail of the Mizen three-fourths of a mile from the F Buoy and then to $1\frac{3}{4}$ before deepening again to $2\frac{1}{2}$ fathoms at the buoy on its western edge, and on the eastern side of the Western Channel (343).

87. From Long Sand Spit Buoy to E Buoy (46), N. 60° 15′ W., distance 12,710 yards. From 28 feet at the L. S. S. Buoy as it slants away upwards, shoals rapidly after striking the eastern edge of the Long Sand (341) one-fourth of a mile off, crosses the dry patch, which is dry at 10 feet rise of tide, at one-fifth the distance, deepens to 2 fathoms at half the distance, deepens to 3 fathoms in the gut between the Mizen (340) and Long Sands at three-fifths the distance, gradually shoaling across the mile of channel to 2 fathoms on the eastern edge of the tail of the Mizen Sand at three-fourths the distance, strikes the dry sand of the Mizen and deepens to 2 fathoms on the western side of the sand 1 mile from the E Buoy, deepens to $3\frac{1}{4}$ fathoms as it strikes off the sand, and shoals gradually as it runs across the channel diagonally till in 14 feet at the buoy on the eastern edge of the Eagle Sand (339) and on the western side of the Western Channel (343).

88. From Long Sand Spit Buoy to Lower Lloyd's Buoy (41), N. 17° 15′ W., distance 8,100 yards. As it runs up the eastern edge of the Long Sand (341), it shoals from 28 feet at the L. S. S. Buoy to 21 feet at L. L. Buoy. This line marks the extreme western limits of Saugor Roads (349).

89. From Long Sand Spit Buoy to Lower Saugor Flat Buoy (51) (this latter buoy has since been moved to the N. by W. 1,400 yards), N. 11° 15′ E., distance 5,700 yards. Deepens from 28 feet at the L. S. S. Buoy to 5 fathoms but a short distance off, then gradually to 6½ fathoms at the L. S. F. Buoy on S.W. edge of Saugor Flat (347) and eastern side of Saugor Roads (349). On this line is the best anchorage for vessels of heavy draught.

90. From Long Sand Spit Buoy to Upper Middleton Buoy (58), N. 26° 00′ E., distance 3,780 yards. From 28 feet at the L. S. S. Buoy, deepens to 5½ fathoms half way as it, like the last line, crosses diagonally Saugor Roads (349), then shoals to 29 feet at the U. M. Buoy on the eastern side of Saugor Roads.

91. From Long Sand Spit Buoy to Saugor Lighthouse (54), N. 46° 00′ E., distance 7,250 yards. From 28 feet at the L. S. S. Buoy, deepens to 5 fathoms at one-fifth the distance; shoals again to 3½ fathoms on the northern end of the Middleton Spit (348) three-fourths of a mile to the southward of the U. M. Buoy at nearly half the distance, and deepens gradually to 5¾ fathoms near Saugor Beach, which it strikes at four-fifths the distance, thence over land. This line leads well clear off the northern end of Middleton Spit. The Upper Middleton Buoy (58) being now (1880) in deep water.

92. From Long Sand Spit Buoy to Dooblat Grove (77), N. 86° 15′ E., distance 15,300 yards. From 28 feet at L. S. S. Buoy, deepens to 5 fathoms a short distance from it as it crosses Saugor Roads (349), and gradually shoals to 2¾ fathoms, 1,000 yards N.N.E. of M. S. Buoy at one-fourth the distance; deepens to 3 fathoms on the eastern edge of the spit of the Middleton (348) at one-third the distance; then to

$3\frac{1}{2}$ fathoms, shoaling again to $2\frac{1}{4}$ fathoms, which it carries close in to Saugor Beach, which it strikes at three-fifths the distance; thence over land and across the creek to the grove on the south end of Saugor Island (350).

93. **The Saugor Anchoring Buoy.** A second class iron buoy, painted red, marked with a white anchor, and surmounted with a red basket beacon. In 27 feet, close to the steep eastern edge of the Long Sand (341), and marks the extreme western limits of Saugor Roads (349). The line of the two Gasper Lights (127 & 166) in one passes half a mile to the north-east of this line; so when at this buoy, or when Saugor Light (54) bears N. by E. $\frac{1}{2}$ E., the course must be altered from N.W. $\frac{1}{2}$ N. to N.N.W., to fetch the deep water anchorage at the L. S. S. Buoy (85).

94. From Saugor Anchoring Buoy to the F Buoy (63), N. 62° 30′ W., distance 14,000 yards. From 27 feet at Saugor Anchoring Buoy shoals to 2 fathoms on the edge of the Long Sand (341) at half a mile; strikes the head of a dry patch, $4\frac{1}{2}$ miles long, running down S.S.E. on the Long Sand and dry until the tide has risen 10 or 12 feet at one-fifth the distance, and deepens to 2 fathoms on the western edge of the Long Sand at two-thirds the distance, crosses the entrance to the gut running up N.N.E. between the tail of the Mizen Sand (340) and the Long Sand, and which is 2 miles broad; strikes the extreme tail end of the Mizen Sand in $1\frac{1}{2}$ fathoms a quarter mile from the F Buoy, and deepens to $2\frac{1}{2}$ fathoms at it on the eastern side of the Western Channel (343) and close to the tail end of the Mizen Sand.

95. From Saugor Anchoring Buoy to Long Sand Spit Buoy (85), N. 23° 40′ W., distance 4,800 yards. From 27 feet at the Saugor Anchoring Buoy, shoals to $4\frac{1}{4}$ fathoms at one-third the distance, and deepens again to 28 feet at the L. S. S. Buoy as it runs up along the edge of the Long Sand (341). This line marks the extreme western limits of Saugor Roads (349), and must not be borrowed upon as the Long Sand close to the westward of it is steep to.

96. From Saugor Anchoring Buoy to Middleton Spit Buoy* (80), N. 15° 00′ E., distance 3,600 yards. From 27 feet at Saugor Anchoring Buoy, deepens to $4\frac{3}{4}$ fathoms one-fourth the distance as it crosses diagonally up Saugor Roads (349), and then gradually shoals to 19 feet at the M. S. Buoy on the eastern side of Saugor Roads and off the edge of the spit of the Middleton Sand (348).

97. From Saugor Anchoring Buoy to Dooblat Grove (77), N. 68° 15′ E., distance 12,530 yards. Deepens from 27 feet at Saugor Anchoring Buoy to 5 fathoms, from 100 to 800 yards off, and then shoals as it crosses Saugor Roads (349) to 19 feet on the western edge of the Middleton Sand (348) at one-fourth the distance; deepens to 3 fathoms at two-thirds the distance; shoals to 2 fathoms at half the distance, and carries this water till well into the beach, and after crossing the mouth of the creek, strikes the land half a mile from the grove.

98. **The H Buoy.** A second class iron buoy, painted black with white apex, marked with an H in white, and surmounted with a black triangular beacon. Is in 23 feet off the western edge of a prong of the Long Sand (341), running down in a S.S.W. direction similar to the tail of the Mizen Sand (340) above it, and marks the extreme eastern limits of the Western Channel (343), which is here over 3 miles broad, that is, to $2\frac{1}{2}$ fathoms on the eastern edge of the Eastern Brace (335), or in a line of G and I Buoys (68 and 117).

99. From H Buoy to Sola Buoy (71), N. 73° 30′ W., distance 17,300 yards. From 23 feet at the H Buoy, shoals gradually across the Western Channel (343) to $2\frac{1}{2}$ fathoms on the eastern edge of the Eastern Brace (335); at two-fifths the distance shoals on the Brace until on the $3\frac{3}{4}$-mile dry patch at three-fourths the distance; deepens to three-fourths of a fathom and strikes another dry patch three-

* Lately moved 2,000 yards S. by E. $\frac{3}{8}$ E.

fourths of a mile from the Sola Buoy; then deepens gradually to the western edge of the Eastern Brace to 2 fathoms, then suddenly to 2¾ at the S. Buoy on the eastern side of the gut separating the two Braces.

100. From H Buoy to G Buoy (68), N. 39° 45′ W., distance 7,600 yards. From 23 feet at the H Buoy, gradually shoals to 13 feet as it crosses diagonally up the Western Channel (343), and meets the G Buoy in that water on the eastern edge of the Eastern Brace (335) and on the western side of the Western Channel.

101. From H Buoy to F Buoy (63), N. 13° 50′ W., distance 8,950 yards. From 23 feet at the H Buoy, shoals gradually as it runs up the channel to 2½ fathoms at the F Buoy on the western side of the tail end of the Mizen Sand (340), and on the eastern side of the (here) narrow part of the Western Channel (343). This line runs slanting across the wide mouth of the gut which runs up N.N.E., between the Mizen and Long Sands (341) as far as the L. L. Buoy; so that at two-thirds the distance it is in mid channel; but both the buoys are eastern ones for the Western Channel.

102. From H Buoy to Long Sand Spit Buoy (85), N. 51° 46′ E., distance 10,600 yards. From 23 feet at the H Buoy, shoals on the spur or prong of the Long Sand (341) to 2 fathoms half a mile off, and after traversing the Long Sand diagonally, passes just to the southward of a dry patch 1 mile from the L. S. S. Buoy, and deepens suddenly from 1 into 4 fathoms and to 28 feet at the L. S. S. Buoy on the eastern edge of the Long Sand, and on the extreme western side of Saugor Roads (349).

103. From H Buoy to Saugor Anchoring Buoy (93), N. 78° 00′ E., distance 10,500 yards. From 23 feet at the H Buoy, shoals across the spur or prong of the Long Sand (341), and deepens in a narrow gut; then crosses the Long Sand and strikes the half-tide dry patch at four-fifths the distance; deepens suddenly from 2 to 4 fathoms off the eastern edge of the Long Sand, and to 27 feet at the Saugor

Anchoring Buoy close to it, and on the western side of Saugor Roads (349).

104. **The Upper Eastern Gasper Buoy.*** A second class wooden buoy, painted black, marked U. G. in white, and surmounted with a black ball beacon. Is moored in 19 feet off the western edge of the Middleton Sand, and marks the extreme eastern limits of the channel forming the junction of Saugor Roads (349) with the Gasper Channel (351). The channel here is 4,300 yards wide. The flood-tide sets strong on to the Middleton Sand here, especially after half flood.

105. From Upper Eastern Gasper Buoy to Saugor Anchoring Buoy (93), N. 78° 00′ W., distance 5,380 yards. From 19 feet at U. *E.* G. Buoy, gradually deepens to 4 fathoms at half the distance, as it strikes diagonally across and up Saugor Roads (349); then to 5 close to Saugor Anchoring Buoy, and shoals to 27 feet at the buoy on the western limits of Saugor Roads and just off the steep eastern edge of the Long Sand (341).

106. From Upper Eastern Gasper Buoy to Middleton Spit Buoy† (80), N. 42° 45′ W., distance 6,250 yards. From 19 feet at the U. *E.* G. Buoy, shoals to 3 fathoms half way on the edge of the Middleton Sand (348), as it slightly bulges out, and then deepens again to 19 feet and carries that water to the buoy, as it runs up the extreme eastern limits of Saugor Roads (349) and off the western edge of the Middleton Sand.

107. From Upper Eastern Gasper Buoy to Saugor Lighthouse (54), N. 10° 40′ W., distance 10,700 yards. From 19 feet at the U. *E.* G. Buoy, shoals gradually to 3 fathoms on the Middleton Sand (348), and carries this in its course across the junction of the spit with Middleton Sand for one-fifth the whole distance, and carries nothing less right across the spit to 3 fathoms in the gut at the eastern

* Lately moved 1,500 yards S. ¾ E.

† Lately moved 2,000 yards S. by E. ⅝ E.

side of the spit at nearly half the distance, and with Dooblat Grove (77) bearing east. Then deepens to $4\frac{3}{4}$ fathoms before striking the beach, which on this line can be approached very close, say 400 yards, at 1,100 yards from the Saugor Lighthouse; thence across land overgrown with jungle. Between the point where this line strikes the beach and the U. M. Buoy, a distance of 3,500 yards, anchorage of $5\frac{3}{4}$ fathoms is found.

108. From Upper Eastern Gasper Buoy* to Dooblat Grove (77), N. 37° 00′ E., distance 6,800 yards. From 19 feet at the U. *E.* G. Buoy, shoals gradually to 3 fathoms at one-sixth the distance on the Middleton Sand (348), then to $1\frac{3}{4}$ fathoms at half the distance, and deepens to 12 feet between the Middleton Sand and the beach, strikes the beach at five-sixths the distance, and thence to Dooblat Grove on the southern end of Saugor Island (350). With a moderate sea on, the rollers break on the $1\frac{3}{4}$-fathom patch on this line.

109. From Upper Eastern Gasper Buoy* to Sidney Point (354), N.E. by E. $\frac{3}{4}$ E., distance 6 miles. From 19 feet at the U. *E.* G. Buoy, shoals on the Middleton Sand (348) to 18 feet three-eighths of a mile off, to 12 feet 1 mile off, to 10 feet at one-fourth the distance, deepening again to 12 feet at half the distance, gradually shoaling again to 9 feet at four-fifths the distance, and continues shoaling as the Point is approached.

110. From Upper Eastern Gasper Buoy* to Pitt's Point (see 353), E. by N. $\frac{1}{4}$ N., distance $8\frac{5}{8}$ miles. From 19 feet at the U. *E.* G. Buoy, shoals on the edge of the Middleton Sand (348) to 18 feet at three-eighths of a mile, to 12 feet at less than a mile distance, to 9 feet $1\frac{1}{2}$ miles off, and when at a point about three-eighths of a mile north of the 6-feet patch, then gradually deepens again to 12 feet at three-eighths the distance, and to 13 feet in the head of the gut—the termination of the Eastern Channel, running up from the Lower Gasper Light Vessel (166) towards Dooblat

* Lately moved 1,500 yards S. $\frac{3}{4}$ E.

Grove (77); shoals again to 12 feet at half the distance, and to 4 feet at five-eighths the distance, and to 2 feet as it crosses near to the northward of some dry patches at the head of Edmonstone Sand (354); it then deepens to 3 fathoms on the western limits of the Barratulluh River or Channel Creek at $1\frac{1}{4}$ miles from Pitt's Point, and to even 10 fathoms just before it strikes the Point on the S.W. side of the eastern division of Saugor Island (353).

111. **The Western Brace Buoy.** Second class, wood, painted red, marked W. B. in white, and surmounted with a red open basket beacon. In 17 feet just off the eastern edge of the Western Brace (331), and on the western side of the channel or gut running up between the two braces, here $3\frac{3}{4}$ miles broad. In Lat. 21° 32′ N., Long. 87° 38′ 45″ E.

112. From Western Brace Buoy to the centre of Pipley Sand (330), which lies opposite to the mouth of, and forming a delta to, the Soobunreeka River. Due west $16\frac{1}{2}$ miles. From 19 feet at the W. B. Buoy, shoals at once on the eastern edge of the Western Brace (331) to $2\frac{1}{2}$ fathoms, then to $1\frac{1}{2}$ fathoms at 1 mile distance, gradually deepens again to 3 fathoms off the western edge of the Brace at one-fifth the distance, to $3\frac{3}{4}$ fathoms at one-fourth the distance at the head of Balasore Roads (332), shoals to 3 fathoms at three-fourths the distance on the edge of the extensive Flats off the beach, and then gradually shoaling until the dry Pipley Sand is reached.

113. From Western Brace Buoy to the nearest part of Balasore Beach (332), N.N.W., 5 miles. From 19 feet at the W. B. Buoy, shoals at once on the eastern edge of the Western Brace (331) to $2\frac{1}{2}$ fathoms, then to $1\frac{1}{4}$ at one-third the distance, deepens to $2\frac{1}{2}$ fathoms on the western edge of the Western Brace at half the distance, and shoals to 1 fathom on the mud flat, three-fifths of a mile from the beach. This line strikes in midway of two creeks—Mander Mohan, the easternmost, and Deegwah Mohan, the southernmost, which latter has sandhills on both sides of it.

114. From Western Brace Buoy to Dariapore G. T. S. Bungalow, N. 36° 45′ E., distance 38,050 yards. From 19 feet at the W. B. Buoy, carries the same water for $2\frac{1}{4}$ miles as it skirts the eastern edge of the Western Brace (331), then runs up the Western Brace Head, shoaling to 1 fathom at one-fourth the distance, deepening to 2 fathoms at two-fifths the distance, passing for $4\frac{1}{2}$ miles half a mile to the westward of a narrow dry tongue of sand, stretching down S.W. from the shore at Sandhill mark, where the Brace Head joins the land; strikes the land at two-thirds the distance; passing three-fourths of a mile to the westward of Sandhill mark on its way over land at three-fifths the distance; thence on to Dariapore Bungalow on the southern side of Hidgilee Creek.

115. From Western Brace Buoy to Sola Buoy (71), N. 60° 30′ E., distance 15,080 yards. From 19 feet at the W. B. Buoy, carries $3\frac{1}{4}$ and $3\frac{1}{2}$ fathoms diagonally up and across the gut or channel, separating the two Braces to the S. Buoy on its eastern side and on the edge of the Eastern Brace (335). This is the track pursued by vessels bound to Balasore, and who cross the Eastern Brace Head between two nun buoys, which mark respectively the tail of the northern dry patch and the head of a southern one on the Brace Head about $2\frac{1}{2}$ miles to the southward of the Eastern Brace Fairway Buoy (30). There is nothing less than $1\frac{3}{4}$ fathoms across the Western Brace (331) at the W. B. Buoy, and 2 fathoms a mile below it.

116. From Western Brace Buoy to Saugor Lighthouse (54), E. by N. $\frac{3}{4}$ N., 22 miles. From 19 feet at the W. B. Buoy, deepens to 4 fathoms on the eastern side of the channel running up between the two Braces (335 and 331) at $3\frac{3}{4}$ miles, then deepens quickly to 2 fathoms on the western edge of Eastern Brace, carries half a fathom at 6 miles distance, passing close to tail of long dry patch; deepens to $2\frac{1}{2}$ fathoms at half way, midway of G and I Buoys, and to 4 fathoms in Western Channel (343) at 15 miles distance; then shoals to 2 and 1 and crosses the dry

part of the Long Sand (341), and deepens to 5½ fathoms off its eastern edge, 1 mile north of L. S. S. Buoy on the western limits of Saugor Roads (349); shoals to 3½ fathoms on the northern verge of Middleton Spit (348) and close to U. M. Buoy; deepens again towards Saugor Beach to 6 fathoms; strikes the beach and over land to the Lighthouse.

117. **The I Buoy.** Second class, iron; painted white with black apex, marked I in black, and surmounted with a red open basket beacon. In 3 fathoms on the western side of the Western Channel (343) and 1¼ miles from the eastern edge of the Eastern Brace (335), and is abreast the head of a channel of 3¼ fathoms, which runs down in a S.W. direction between the head of the Western Sea Reef (336) and the eastern side of the Eastern Brace.

118. From I Buoy to Western Brace Buoy (111), N. 84° 30′ W., distance 21,100 yards. From 3 fathoms at the I Buoy, deepens to 3¼ fathoms, and then shoals to 2½ fathoms on the eastern edge of the Eastern Brace (335) at 1¼ miles distant; shoals to 1¼ on the Brace, and gradually deepens to 2 fathoms on its western edge at three-fifths the distance; it then deepens off it to 4 fathoms at one-third across the channel which separates the two Braces, here 3¾ miles wide, shoals gradually to 19 feet at the W. B. Buoy on the western side of this gut or channel and on the eastern edge of the Western Brace (331).

119. From I Buoy to Sola Buoy (71), N. 45° 45′ W., distance 13,700 yards. From 3 fathoms at the I Buoy, first deepens one-quarter fathom, and then shoals to 3 fathoms on eastern edge of the Eastern Brace (335) at 1¼ miles; just clears the southernmost end of a dry sand patch 3¾ miles long in the centre of the Eastern Brace, as it traverses the Brace in half or one-quarter fathom at three-fifths the distance; then crosses another smaller dry patch three-fourths of a mile from the S. Buoy, deepens to 3 fathoms off the western edge of the Eastern Brace, and so to the S. Buoy close to, on the eastern side of the channel or gut separating the Eastern and Western Braces (335 and 331).

120. From I Buoy to G Buoy (68), N. 10° 15′ E., distance 10,580 yards. From 3 fathoms at the I Buoy, first deepens on leaving it to 3½ fathoms, then gradually shoals to 2½ fathoms on the extreme edge of the Eastern Brace (335) at half the distance, and carries 13 feet to the G Buoy on the eastern edge of the Eastern Brace and the western side of the Western Channel (343).

121. From I Buoy to H Buoy (98), N. 55° 45′ E., distance 8,110 yards. From 3 fathoms at the I Buoy, deepens one-quarter fathom till in 3 fathoms again at half the distance up and diagonally across the Western Channel (343); then gradually deepens to 3¾ and to 23 feet at the H Buoy off the western edge of the Long Sand (341) and on the eastern side of the Western Channel.

122. **The Upper Thornhill's Buoy.** Second class, wood, painted red, marked U.T. in white, and surmounted with red basket beacon. Lies 500 yards off, and marks the eastern edge of the Long Sand (341), the extreme limits of the lower part of Saugor Roads (349) and the western side of the head of Thornhill's Channel (which is now closed), and is moored in 24 feet of water. Vessels cannot pass to the westward of a line between this buoy and the Saugor Anchoring Buoy to the N.N.W. of it, as the Long Sand has considerably bulged out midway of the two buoys.

123. From Upper Thornhill's Buoy to H Buoy (98), N. 72° 30′ W., distance 14,000 yards. From 24 feet at the U. T. Buoy, shoals to 2½ fathoms on the eastern edge of the Long Sand (341), after running the 500 yards between it and U. T. Buoy; then crosses the tail of the half-tide patch of dry sand, which runs up to above the Saugor Anchoring Buoy, deepens to 2 fathoms in a gut between the western edge of the Long Sand proper and a spur or spit branching out from it into the Western Channel (343) at three-fourths the distance; it then shoals on the spur, prong, or spit, and deepens off the western edge of the sand to 23 feet at the H. Buoy close to it, and on the eastern side of the Western Channel.

124. From Upper Thornhill's Buoy to Saugor Anchoring Buoy (93), N. 25° 45′ W., distance 7,100 yards. From 24 feet at the U. T. Buoy, shoals to 3 fathoms, as it cuts dangerously close to the steep eastern edge of the Long Sand (341) at half the distance; deepens to 5 fathoms at four-fifths the distance, and shoals to 27 feet at the Saugor Anchoring Buoy just off the eastern edge of the Long Sand and on the western side of Saugor Roads (349). This line forms the extreme western limits of the lower part of Saugor Roads, and must not be borrowed upon.

125. From Upper Thornhill's Buoy to Saugor Lighthouse (54), N. 1° 00′ E., distance 15,890 yards. From 4 fathoms at U. T. Buoy, deepens and carries 4¼ fathoms for one-fourth the distance, then shoals gradually to 4 fathoms in mid channel and when abreast the M. S. Buoy (80), shoals again to 3 fathoms on the western edge of Middleton Spit (348) at half the distance; crosses the spit in 2¾ fathoms, deepening gradually into 5 fathoms in the gut running down between Middleton Spit and the beach at five-sixths the distance; striking the land 400 or 500 yards from 4 fathoms; and thence across the jungle to the Lighthouse.

126. From Upper Thornhill's Buoy to Upper Eastern Gasper Buoy* (104), N. 22° 00′ E., distance 5,750 yards. From 4 fathoms at the U. T. Buoy, deepens to 4¼ until one-third the distance as it runs up and across Saugor Roads (349), shoals again to 4 fathoms at half the distance, and gradually to 19 feet at the U. *E.* G. Buoy on the western edge of the Middleton Sand (348), and on the extreme eastern limits of the lower part of Saugor Roads.

127. **The Upper Gasper Light† Vessel and Upper Western Gasper Buoy.** A vessel with

* This buoy has been lately moved 1,500 yards S. ¾ E.

† From the River Surveyor's Reports, dated 20th March 1881, we learn that the Upper Gasper Light is placed in position as follows:—Upper Eastern Gasper Buoy (104) on Saugor Lighthouse (51), N. 10° W., Centre Eastern Gasper Buoy (133), N. 76° E., and Upper Western Thornhill's Buoy (122), West, Magnetic.

three masts, having one yard on the fore only, hull painted yellowish clay colour, and has Upper Gasper on her sides in black. By day, to denote her being in position, flies a white flag with a red celestial device, such as a star, meteor, or comet (as her name happens to be); and by night shows a powerful dioptric light at half mast; the reason that it is hoisted half mast being, that observers coming up the Eastern Channel (356) shall not raise it above the horizon until 2 miles below the Lower Gasper (166), so as not to confound the two lights the one for the other; fires a gun in fogs, at the 1st and 3rd quarters of the hour, and rings a bell at intervals. Is moored in 21 feet in Lat. 21° 31′ 00″ N., Long. 88° 2′ 53″ E., just off the N.W. Spit of the Gasper Sand or Middle Ground on the western side of the Gasper Channel (351); so that vessels must pass to the N. E. of her. Kept on with the Lower Gasper Light she is a leading mark for Saugor Roads (349) up to a short distance above Saugor Anchoring Buoy (93), or, when Saugor Light bears N. by E. ½ E., it then strikes the Long Sand (341). As per Admiralty Regulations, she shows also an anchor light at her forestay to denote which way her head is; and when driven off her position by night, shows a red light at each end, and burns a red flare-up every quarter of an hour, and by day strikes her masthead flag. As it happens sometimes, through some accident, that one of the regular light vessels is disabled; in that case a brig is placed in position here, and her distinctive signal of being in position is, by day, a white flag with a red St. George's cross in it; and by night a lantern at each foreyard arm; and also she burns a maroon every quarter of an hour to distinguish her from any other vessel at anchor. The Upper Western Gasper Buoy is moored in 3¼ fathoms, 500 yards to the W.S.W. of her, on the extreme end of the Gasper Sand; and is a second class iron buoy, painted red, marked U. G. in white, and surmounted with a red open basket beacon: and lies just to the southward of a line between the U. T. Buoy (122), and the C. *E*. G. Buoy (133), the Upper

Gasper Light Vessel lying to the northward of it. Of course, when the vessel has to ride by a long scope of chain, she will be further over into the fairway of the channel. High water at F. and C. at the Upper Gasper Light Vessel, 9h. 45m., after which the tide runs up for nearly an hour, and the same at low water, the tide continues to run down for an hour after it has begun to rise. Rise of tide springs 14 feet; neaps 11 feet.

128. From Upper Gasper Light Vessel to Upper Thornhill's Buoy, N. 86° 10′ W., distance 3,150 yards. From 21 feet at U. G. Light V., gradually deepens half way across, which is the centre of the head of the old Thornhill's Channel, and continues that depth to the U. T. Buoy, 500 yards off the eastern edge of the Long Sand at the western side of the head of Thornhill's Channel, and on the western side of the lower part of Saugor Roads (349).

129. From Upper Gasper Light Vessel to Saugor Anchoring Buoy (93), N. 45° 00′ W., distance 8,790 yards. From 21 feet at the U. G. Light V., gradually deepens to 4½ fathoms half way and to 5 fathoms 15 yards below the Saugor Anchoring Buoy, shoaling to 27 feet at it, 250 yards from the steep eastern edge of the Long Sand (341) and on the western side of Saugor Roads (349). When in this patch of 5 fathoms Saugor Light bears N. by E., and the line of the two Gasper Lights on just cuts the eastern edge of it, but as there are no other lights to guide you, it is risky to run to the westward of the line of the two Gasper Lights in one, having to depend entirely on the compass bearing of Saugor Lighthouse, 4¾ miles from the Saugor Anchoring Buoy. And on the other hand, the Lower Gasper Light (172) kept open to the eastward, only half a point, of the Upper Gasper Light, fouls the Middleton Spit Buoy, on the western edge of the Middleton Spit, which has only 2½ fathoms on its centre to the N. by E. of the latter buoy.

130. From Upper Gasper Light Vessel to Middleton

Spit Buoy (80), N. W. by N. ½ N., distance 11,000 yards.* From 21 feet at the U. G. Light V., gradually deepens to 3¾ fathoms, with a cast of 4 fathoms at half the distance, shoaling again gradually to 19 feet at the M. S. Buoy. The flood-tide sets strong across this line, so that vessels have to lay much higher than the course here given to weather the last named buoy with a S.W. wind blowing; in fact, have to steer almost the same course which took them through the Gasper Channel (351) till up to the M. S. Buoy.

131. From Upper Gasper Light Vessel to Upper Gasper (Eastern) Buoy† (104), N. 10° 40′ W., distance 5,200 yards. From 21 feet at U. G. Light V., shoals to 3⅜ fathoms at half the distance, and to 19 feet at the U. *E.* G. Buoy off the western edge of the Middleton Sand (348), and on the eastern limits of the junction of Saugor Roads (349), with the Gasper Channel (351) to the southward. The flood and ebb-tides set about up and down this line at half tide; and after that more to the right.

132. From Upper Gasper Light Vessel to Dooblat Grove (77), N. 31° 45′ E., distance 13,600 yards. From 21 feet at the U. G. Light V., gradually shoals across the head of the Gasper Channel (351) to 3 fathoms at a quarter the distance, and soon after to 1½ fathoms on the Middleton Sand (348), then gradually deepens again to 2 fathoms at one-third the distance, to 1½ fathoms four-fifths the distance, and shoals on to the land, and thence to the Grove on the south end of Saugor Island, W. D. (350).

133. **The Centre Eastern Gasper Buoy.** Second class, iron, painted black, marked C. G. in white, and is surmounted with a black ball beacon. In 18½ feet just off the southern spit or prong of the Middleton Sand (348), on to which the flood-tide sets strong, and on which

* The Middleton Spit Buoy has been moved lately S. by E. ⅝ E. 2,050 yards.

† This buoy has been lately moved 1,500 yards, S. ¾ E.

the rollers break, with a moderate sea on. Marks the extreme eastern limits of the Gasper Channel (351).

134. From Centre (East) Gasper Buoy to Upper (West) Gasper Buoy (127), N. 85° 18′ W., distance 3,180 yards. This line also nearly strikes the U. T. Buoy (122) beyond. From 18½ feet at the C. *E.* G. Buoy, gradually deepens to 3⅜ fathoms when passing the U. G. Light V. as it crosses the Gasper Channel (351), and then shoals again to 3¼ fathoms at the U. *W.* G. Buoy on the N.W. end of the Gasper Sand or, as now called, the head of the Middle Ground (352) on the eastern side of the head of Thornhill's Channel (346) and on the western side of the junction of the Gasper Channel with Saugor Roads (351 and 349).

135. From Centre Eastern Gasper Buoy to Upper Gasper Light Vessel (127), N. 75° 30′ W., distance 2,700 yards. Gradually deepens across the channel from 18½ feet at the C. *E.* G. Buoy to 21 feet at the U. G. Light V. on the eastern side of the Gasper Channel (351) and near N.W. prong of the Gasper Sand, or as now called, the head of the Middle Ground (352).

136. From Centre Eastern Gasper Buoy to Upper Eastern Gasper Buoy (104), N. 31° 00′ W., distance 6,800 yards. From 18½ feet at C. *E.* G. Buoy, deepens to 3¼ fathoms a short distance off, and then carries 3¼ fathoms till close to the U. *E.* G. Buoy, and carries 19 feet to it as it runs up just off the western edge of the Middleton Sand (348). This line marks the extreme eastern limits of the channel here, and the flood-tide sets diagonally across it on to the Middleton Sand.

137. From Centre Eastern Gasper Buoy to Dooblat Grove (77), N. 20° 15′ E., distance 13,600 yards. From 18½ feet at the C. *E.* G. Buoy, shoals immediately on the southern spit or prong of the Middleton Sand (348) to 16 feet 1,000 yards off; deepens to 3 fathoms at one-third the distance, shoaling gradually to 10 feet at four-fifths the distance and so shoaling on to the beach 1,200 yards from Dooblat

Grove on the southern end of Saugor Island (350), east of Saugor Point.

138. **The Centre Western Gasper Buoy.** Second class, wood, painted red, marked C. G. in white, and surmounted with a red open basket beacon. Moored in $3\frac{1}{8}$ fathoms just off the N.E. edge of the Gasper Sand (there is not less than 3 fathoms across the prong of the Gasper Sand or head of Middle Ground (352) to the westward of it), and on the extreme western limits of the Gasper Channel (351). Abreast this buoy is the shoalest part of the channel (3¼ fathoms), but 300 yards to the north of it there is a cast of $3\frac{1}{8}$ fathoms.

139. From Centre Western Gasper Buoy to Upper Western Gasper Buoy (see 127), N. 39° 30′ W., distance 3,050 yards. From $3\frac{1}{8}$ fathoms at the C. *W.* G. Buoy, gradually deepens to 3¼ as it runs up along the N.E. edge of the Gasper Sand, or head of Middle Ground (352), till close to the U. *W.* G. Buoy, and then 19 feet to it on the N.W. spit or prong of the Gasper or head of Middle Ground, and on the western limits of Saugor Roads (349) and Gasper Channels (351), and also on the eastern side of the head of the old Thornhill's Channel (346), now closed. Although this line marks the western limits of the Gasper Channel here, there is 19 feet across the spur or head of Middle Ground close to the north-west of the C. *W.* G. Buoy, and 3¼ fathoms half way along this line, deepening to 4 fathoms in the head of Thornhill's with U. T. Buoy N. by W., beyond which it is not safe to stand to the westward.

140. From Centre Western Gasper Buoy to Upper Gasper Light Vessel (127), N. 26° 30′ W., distance 3,150 yards. From $3\frac{1}{8}$ fathoms at the C. *W.* G. Buoy, gradually deepens as it runs up the western side of the Gasper Channel (351) to 21 feet at the U. G. Light V.

141. From Centre Western Gasper Buoy to Centre Eastern Gasper Buoy (133), N. 30° 00′ E., distance 2,450 yards. From $3\frac{1}{8}$ fathoms at the C. *W.* G. Buoy, deepens to 3¼, which

it carries across the channel till it shoals to 18½ feet at the C. *E.* G. Buoy just off the southern prong or spit of Middleton Sand (348) and on the eastern side of the Gasper Channel (351). The channel is 2,300 yards wide abreast the C. *W.* G. Buoy, and there is generally a heavy swell felt on this the shoalest part of the channel, more specially on the first of a flood-tide.

142. **The Lower Eastern Gasper Buoy.** Second class, iron, painted black, marked L. G. in white, and surmounted with a black ball beacon. Lies in 21 feet off the tail of the Middleton Sand (348), marks the extreme eastern limits of the Gasper Channel (351) and the western limits of the extension of the Eastern Channel (356)—a gut of 4 fathoms running up to the eastward of it towards Saugor Beach.

143. From Lower Eastern Gasper Buoy to Centre Western Gasper Buoy (138), N. 85° 30′ W., distance 3,790 yards. From 21 feet at L. *E.* G. Buoy, gradually shoals as it crosses the Gasper Channel (351) diagonally to 3⅛ fathoms at the C. *W.* G. Buoy on the western side of the Gasper Channel and just off the north-east edge of the Gasper Sand, or rather, head of Middle Ground.

144. From Lower Eastern Gasper Buoy to Upper Western Gasper Buoy (127), N. 65° 00′ W., distance 6,300 yards. From 21 feet at L. *E.* G. Buoy, shoals to 3¼ fathoms at half the distance as it runs up and across the channel, and carries this depth to the U. *W.* G. Buoy off the N.W. spit of the Gasper Sand or head of Middle Ground, the western side of the junction of Saugor Roads (349) with the Gasper Channel (351), and on the western side of the head of Thornhill's Channel (346).

145. From Lower Eastern Gasper Buoy to Upper Gasper Light Vessel (127), N. 58° 40′ W., distance 6,050 yards. From 21 feet at L. *E.* G. Buoy, shoals gradually to 3¼ fathoms half way, and deepens again gradually to 21 feet at U. G. Light V. This line runs nearly parallel and close to the last one above.

146. From Lower Eastern Gasper Buoy to Centre Eastern Gasper Buoy (133), N. 45° 30′ W., distance 3,500 yards. From 21 feet at L. *E.* G. Buoy, shoals gradually to 3¼ fathoms at two-thirds the distance, and to 18½ feet at C. *E.* G. Buoy off the southern prong or spit of the Middleton Sand (348) and on the eastern side of the Gasper Channel, this line forming an eastern boundary line between the buoys.

147. From Lower Eastern Gasper Buoy to Dooblat Grove (77), N. 7° 45′ W., distance 14,850 yards. From 21 feet at L. *E.* G. Buoy, shoals very gradually up the eastern edge of Middleton Sand (348) to 3¼ fathoms at one-fourth the distance; then deepens again to 21 feet at half the distance, after which there is no survey (but suppose there is 2 to 2½ fathoms till well into Saugor Beach), striking the beach 1,200 yards from Dooblat Grove on the southern end of Saugor or Saugor Point, thence over land to the Grove.

• 148. **The J Buoy.** Second class, iron, painted black with white apex, marked J in white, and surmounted with a black open basket beacon. Is moored in 3¾ fathoms 1 mile S.S.W. of the tail of the prong of the Long Sand (341) and 2 miles to the westward of 3 fathoms on the western edge of the Long Sand, and is an eastern buoy for the junction of Western and South Channels (343 and 344). Is in Lat. 21° 29′ N., Long. 87° 57′ E.

149. From J Buoy to I Buoy (117), N. 66° 45′ W., distance 7,490 yards. From 3¾ fathoms at the J Buoy, shoals gradually to 3½ fathoms at half the distance, and to 3 fathoms at the I Buoy 1¼ miles to the eastward of the eastern edge of the Eastern Brace (335), on the western side of the Western Channel (343), and in the fairway of a channel running down S.S.W. between the head of the Western Sea Reef (336) and the eastern side of the tail of the Eastern Brace. This line passes about 1¼ miles to the northward of the head of the Middle Ground of the Western Channel (217).

150. From J Buoy to H Buoy (98), N. 1° 15′ W., distance 7,000 yards. From 3¾ fathoms at the J Buoy, shoals gradually to 3 fathoms as it skirts the western edge of the tail of the prong of the Long Sand (341) at half the distance, and deepens again as it edges away a little from the sand on its right to 23 feet at the H Buoy, off the western edge of the prong of the Long Sand and on the eastern side of the Western Channel (217). This line is the eastern limit of the Western Channel here.

151. From J Buoy to Saugor Anchoring Buoy (93), N. 46° 15′ E., distance 14,090 yards. From 3¾ fathoms at the J Buoy, deepens to 4¼ fathoms 1 mile off the J Buoy, then it gradually shoals to 3⅛ fathoms off the tail of the prong of the Long Sand (341), cropping out on its western edge, so that the mouth of the gut it forms is 1½ miles broad here: it then deepens again to 4¾ fathoms, and shoals very suddenly on the western edge of the Long Sand to 2 fathoms at one-third the distance. It then crosses the Long Sand and strikes the western edge of the 2¼-mile half-tide dry patch running down the eastern side of the Long Sand at five-sixths the distance, crosses it and deepens suddenly off its very steep eastern side from 2 into 4 fathoms, and to 27 feet at the Saugor Anchoring Buoy, just off its eastern edge and on the western side of Saugor Roads (349).

152. From J Buoy to Upper Thornhill's Buoy (122), N. 75° 40′ E., distance 13,600 yards. From 3¾ fathoms at the J Buoy, gradually deepens to 5 fathoms 1½ miles off, shoaling again to 3 fathoms on the western edge of the Long Sand (341) at two-fifths the distance; then quickly to 2 fathoms. It then crosses the Long Sand just clearing the southern end of the tail of the 2¼-mile half-tide dry patch half a mile west of the U. T. Buoy, then deepens suddenly off the steep eastern edge of the Long Sand from 2 fathoms to 4 fathoms at the U. T. Buoy, on the western side of the junction of Thornhill's Channel (346) with the lower part of Saugor Roads (349).

153. **The Western Channel Upper Middle Ground Buoy.** Second class, wood, painted red and white in vertical sections, and with white apex, is marked U. M. G. in black, and has a red open basket beacon. Is moored in 4¼ fathoms off the eastern edge of the north end of the Middle Ground (217) of the Western Channel, and on the western side of the Western Channel (343).

154. From Upper Middle Ground Buoy (W. C.) to I Buoy (117), N. 36° 45′ W., distance 7,490 yards. From 4¼ fathoms at the U. M. G. Buoy, gradually shoals to 3¾ fathoms on the north end of the Middle Ground (217) of the Western Channel at one-third the distance, and to 3½ fathoms half the distance, gradually shoaling across the head of the channel running down between this sand and the head of the Western Sea Reef (336) to 2 fathoms at the I Buoy 1¼ miles off the eastern edge of the Eastern Brace (335) and on the western side of the Western Channel; also in the fairway of two channels, the one separating the tail of the Eastern Brace from the head of the Western Sea Reef, and the other separating the Western Channel Middle Ground from the head of the Western Sea Reef, the first branching off about S.S.W., and the latter about S. by E.

155. From Upper Middle Ground Buoy (W. C.) to J Buoy (148), N. 36° 15′ E., distance 3,850 yards. From 4¼ fathoms at the U. M. G. Buoy, shoals gradually to 3¾ fathoms at the J Buoy as it runs up and across the Western Channel. Both the J Buoy and the I Buoy (117) are some distance out into the fairway of the channel.

156. **The Lower Western Gasper Buoy.** Second class, wood, painted red, marked L. G. in white, and surmounted with a red basket beacon. In 3½ fathoms just off the N.E. edge of the Gasper Sand, or, as now termed, the head of the Middle Ground, and marks the extreme south-western limits of the Gasper Channel (351). The rollers break on the shoal part of the Gasper Sand 1,500 yards S. W. and west of the buoy, with even a moderate swell on.

157. From Lower Western Gasper Buoy to Upper Thornhill's Buoy (122), N. 48° 00′ W., distance 0,100 yards. From 3½ fathoms at the L. *W.* G. Buoy, shoals gradually as it skirts and crosses diagonally the Gasper Sand, or head of Middle Ground, to 2¾ fathoms at two-fifths the distance; then gradually deepens again to 3 fathoms at half the distance, and to 3½ off the western edge of the Gasper Sand and into the head of the Thornhill's Channel (346), (running down to the westward of the Gasper Sand), deepening to 4 fathoms 1,000 yards from, and to the U. T. Buoy, off the eastern edge of the Long Sand (341) and on the western side of the junction of Thornhill's and Gasper Channels (346 and 351) with Saugor Roads (349). Since this triangulation, both buoys have been moved more out into the channel, and the distance now between the two butts is 8,800 yards.

158. From Lower Western Gasper Buoy to Centre Western Gasper Buoy (138), N. 32° 45′ W., distance 4,150 yards. (This was by the last triangulation, but since that the L. *W.* G. Buoy has been shifted, and on the latest chart the bearing and distance of the C. W. Gasper Buoy from it is N.W. ½ N., distance 3,800 yards.) From 3½ fathoms at the L. *W.* G. Buoy, gradually shoals to 3⅛ fathoms at the C. *W.* G. Buoy as it runs up along the south-western side of the channel and just off the north-eastern edge of the head of the Middle Ground (352).

159. A line from Lower Western Gasper Buoy (138) to Upper Gasper Light (127) cuts the N.E. edge of the Gasper Sand, or head of the Middle Ground, to the westward of the Centre Western Gasper Buoy, so, therefore, should the C. *W.* G. Buoy be out of position, allowance must be made by keeping more to the north-eastward, or in a line of the two light vessels (see 168).

160. From Lower Western Gasper Buoy to Lower Eastern Gasper Buoy (142), N. 25° 00′ E., distance 3,500 yards. (Since the L. *W.* G. Buoy was shifted, the distance is 3,000 yards only.) From 3½ fathoms at the L. *W.* G.

Buoy, deepens and carries 23 feet right across the Gasper Channel (251) to 21 feet at the L. *E.* G. Buoy, on the eastern side of the Gasper Channel, and off the tail of the Middleton Sand (348).

161. **The Lower Western Thornhill's Buoy** (not in the statement of buoys for 31st December, 1879) was a red buoy, &c., and was off the eastern edge of the tail of the Long Sand (341) and on the western side of the Thornhill's Channel (346) (now closed) leading down to the Reef Head Passage (345).

162. **The Lower Eastern Thornhill's Buoy.** Second class, wood, painted black with L. T. in white, and surmounted with black basket beacon. In 2½ fathoms just off the western edge of the head of the Eastern Sea Reef (342), and on the eastern limits of the (now closed) Thornhill's Channel (346).

163. From Lower Eastern Thornhill's Buoy to the position of the Lower Western Thornhill's Buoy (161) (since removed), N. 43° 00′ W., distance 1,890 yards. From 2½ fathoms at the L. *E.* T. Buoy, deepens across the Thornhill's Channel (346) to 3 fathoms, as it runs diagonally up across it.

164. From Lower Eastern Thornhill's Buoy to Upper Thornhill's Buoy (122), N. 21° 30′ E., distance 8,450 yards. From 2½ fathoms at the L. *E.* T. Buoy, shoals to 2 fathoms as it closes upon and strikes the western edge of the head of the Eastern Sea Reef (342), which bulges out at two-fifths the distance; deepens to 3 fathoms at four-fifths the distance; shoals to 2¼ on the eastern edge of the Long Sand (341) half a mile below the U. T. Buoy; and deepens to 24 feet at the buoy.

165. From Lower Eastern Thornhill's Buoy to Centre Western Gasper Buoy (138), N. 56° 45′ E., distance 9,500 yards. From 2½ fathoms at the L. T. Buoy, shoals to 1¼ fathoms on the Eastern Sea Reef Head (342) at one-fifth the distance; deepens gradually to 12 feet on the

eastern edge of this sand at one-third the distance, and to 21 feet at half the distance, or when in a line of T. P. Buoy to the south, and U. T. Buoy to the north [which is a narrow channel running down to and joining the Eastern Channel (356) below the Bell Buoy (209)]; then shoals gradually to 17 feet on the head of the Gasper Sand or Middle Ground (352), 500 feet from the C. *W*. G. Buoy; deepening again to 18 feet at this buoy, on the extreme western limits of the Gasper Channel (351) and off the eastern edge of the head of the Middle Ground.

166. **The Lower Gasper Light Vessel.*** Anchored in 27 feet at the junction of Eastern and Gasper Channels (356 and 351), and about one-fourth the distance across the channel from the eastern edge of the head of the Middle Ground; or the junction of that sand with the tail of the Gasper sand (the whole is now the Middle Ground). In Lat. 21° 26′ 15″ N., Long. 88° 6′ 8″ E. Light fixed, bright, 48 feet high; burns a blue light every hour, at the half hour from 1st February to 30th November (but burns no maroon or flare-up lights at the hour as heretofore): and burns a blue light every consecutive half hour from the 1st December to the 31st January, or during the time the Intermediate Light Vessel (238) will be periodically removed to town for repairs, &c. During fogs she fires a gun every 30 minutes or at the hour and half-hour, and rings her bell at intervals. This vessel has three masts with a yard on the fore, mast heads and yard painted white. To denote being in position by day, she flies a white flag with celestial device, according to name of vessel, in red, upon it, at the main or lantern mast head, which flag is struck when the vessel is out of position, but the flag cannot be seen far off: and by night, she shows, in addition to her mast head light, the usual regulation

* From the River Surveyor's Report, dated 20th March, 1881, we learn that the "Lower Gasper Light is placed in position as follows:—Station Buoy (172), S. 46° W., Upper Saugor Sand Buoy (181), S. 58° E., and the Lower Western Gasper Buoy (156), N. 44° W., Magnetic."

bright light at the forestay; and when driven off her station, she shows a red light at each end, and a red flare-up every quarter of an hour. She is painted of a yellowish clay or buff colour, as all the others are painted,* and has LOWER GASPER, in 18-inch letters on each side, black on white ground. This light on with the Upper Gasper Light (127) is a lead into the lower part of Saugor Roads (349) to just above the Saugor Anchoring Buoy (93), where it meets the Long Sand (341). The tide sets right round the compass with the hands of a watch: the first of the flood N.N.W., last N.E., and first of ebb S.E., and last to the S.W., and this whirl of the tide may be said to be felt more or less all over the Sandheads all the year round, excepting at the time when a cyclonic movement is set up in the currents of the sea at the Sandheads: when there is a perpetual westerly set of sometimes 5 or 6 knots over the sands up as far in shore, as even this Light Vessel, thus making it very difficult for sailing vessels, when caught in the Eastern Channel, to get either in or out with easterly, or N.E. winds, even.† As was the case with the ill-fated "Grand Duchess" lost with all hands in the cyclone of 1874. High water full and change nine hours six minutes; rise of tide springs 13 feet, neaps 10½ feet, but the tide-stream runs for about an hour after these times. When running into Saugor with a S. W. wind, and although having to haul close to the wind to get through the Gasper, it is not advisable to cross the hawse of this light on a flood-tide; as, from the position of the Lower Western Gasper Buoy (see 159) being but very little to the S.W. of a line of the two Light Vessels, and certainly to the north-eastward of a line between the Gasper Station Buoy (172) and the Upper Gasper Light Vessel, there is very little necessity for so doing, especially at night, when it is hard to judge distance. The lights of all

* It is in contemplation to paint all the light-vessels red, to make them more conspicuous than they are now.

† Consult table 379 and what is said in connection therewith.

the Light Vessels are very powerful and can be seen as soon as the light is raised above the horizon, as if it were quite near, although 10 or 11 miles off. Of course, on first sighting a light, it can be easily ascertained if, or not, it is one of the dioptric lights which these vessels hoist; as, by dipping the eye a foot or so, the light disappears below the horizon at once, which is not the case with other common lights worn by steam vessels, or anchor lights. The blue lights burnt by these Light Vessels throw so much light aloft on the lower surface of passing clouds, that, on favorable (dark, clear, and cloudy) nights, they have frequently been of use to the mariner at a distance of 34 or 35 miles.

167. From Lower Gasper Light Vessel to Lower Western Gasper Buoy (156), N. 52° 30′ W., distance 4,400 yards. From 27 feet at the Lower Gasper Light Vessel, gradually shoals to 24 feet at three-fifths the distance, and to 21 feet at the L. *W.* G. Buoy.

168. From Lower Gasper Light Vessel to Upper Gasper Light Vessel (127), N. 38° 45′ W., distance 11,450 yards. From 27 feet at the Lower Gasper Light Vessel, gradually shoals to 24 feet at one-fourth the distance, to 21 feet at half the distance, to 19 feet at three-fourths the distance, and when abreast of the C. *W.* G. Buoy, which is the shoalest spot in this, the best track through the Gasper Channel (351); and deepens again to 21 feet at the Upper Gasper Light Vessel.

I will here note the peculiarities in the deviation of ships' compasses which I have seen. I find that in iron vessels which have their correcting magnets in the same positions in which they were when their compasses were adjusted in England, have about the greatest amount of left or westerly deviation with their heads about N.W., or N.W. by N. This is about the course through the Gasper Channel from Light to Light, as last given; so that I have often been surprised to find the ship running free through this channel instead of, as I had reason to expect, (from the wind direction as given by the compass), being braced sharp on the port tack: and this too on board

vessels, the masters of whom missed no opportunity of taking amplitudes or azimuths; and, probably, the reason is, that the magnetic dip and horizontal force alters very rapidly in running up the Bay. Again, it is invariably found that masters of vessels, when running over from the Pilot's Ridge (328), find they have got to windward of their course; and the reason is, that in most ships that have compasses and magnets, the same as when they left England after correction, the N.E. by E. point has the maximum amount of right or easterly deviation. The "heeling error" too, of necessity, not so easily verified as is the deviation of the compass, makes the ship appear to be going more to the right than she really is going when on the port tack in these latitudes, with a S.W. or W.S.W. wind blowing fresh and heeling the vessel over. But I do not intend these as hard and fast rules, but simply to point shipmasters to them with the additional warning that *this is not always the case.* With a vessel's head N. by W., which is the Eastern Channel Course (290), there is generally very little deviation.

In running through the Gasper Channel at night it is best to keep a little to the N. E. of this line (from L. to U. Gasper Light) so as to keep clear of the steep N.E. edge of the Gasper Sand, or, as it is now called, the head of the Middle Ground.

169. From Lower Gasper Light Vessel to Lower Eastern Gasper Buoy (142), N. 19° 30′ W., distance 6,120 yards. From 27 feet at the L. G. Light V., shoals gradually to 24 feet at three-fifths the distance, and to 21 feet at the L. *E.* G. Buoy off the tail of the Middleton Sand (348) and on the eastern side of the Gasper Channel (351).

170. From Lower Gasper Light Vessel to Dooblat Grove (77) North, distance 20,900 yards. From 27 feet at L. G. Light V., gradually shoals to 24 feet at one-fifth the distance, to 21 feet at two-fifths the distance, to 19 feet at three-fourths the distance, and to 9 feet 2,000 yards from dry land; thence to the grove, as the line runs up the narrowed gut, or continuation of the Eastern Channel (356) between the dry Edmonstone Sand (354) on the eastern, and the Middleton Sand (348) on the western, side. After

shoaling into 16 feet or so on this line, or about 4,000 yards from the white sandy beach, a line parallel with the beach from this point leads right into Saugor Roads (349), at the back of the Middleton Sand, with not less than 11 feet in it. (It is H. W. at Sidney Point on full and change days at 11h. with a rise of 12 to 13 feet.)

171. From Lower Gasper Light Vessel to House of Refuge No. 1 (390) on Seyer Point (near some tall trees, Jackson's Grove, which have the appearance from this position of a vessel's three masts). N. E. $\frac{1}{4}$ E., $9\frac{3}{4}$ miles.

From 27 feet at Lower Gasper Light Vessel (166), deepens to 28 feet at one-fifth the distance close to the steep western edge of the head of Saugor Sand (355), then shoals suddenly till in 1 fathom at one-third the distance; crosses the dry tail of Edmonstone Sand (354) at half the distance; deepens off the eastern edge of this sand into 7, 8, and 9 fathoms at four-fifths the distance, and carries deep water across the mouth of Barratulla River, or Channel Creek (see 350 to 353), close to Seyer Point, on its left bank; but, to the House of Refuge and before striking the land, it crosses three-fourths of a mile of mud flat which stretches off the land, beginning at Seyer Point, $1\frac{1}{4}$ miles to the southward of the House of Refuge No. 1 (396).

172. **The Lower Gasper Light Station Buoy.** Second class, wood, painted in red and white vertical sections, surmounted with a red basket beacon, and marked S. in black. Is moored in 24 feet on the eastern edge of the Middle Ground (352) and on the western side of the junction of Eastern and Gasper Channels (356 and 351), marks the Light Station in the event of the Light Vessel driving.

173. From Gasper Station Buoy to Lower Western Gasper Buoy (156), N. 30° 30′ W., distance 4,200 yards. From 24 feet at the Station Buoy, gradually shoals to 21 feet at the L. *W.* G. Buoy as it runs up along the western limit of the Gasper Channel (351) and off the

eastern edge of the Middle Ground (352). Vessels must not borrow to the westward of this line as the water shoals rapidly, and there is, in the S. W. Monsoon, a heavy swell here.

174. From Gasper Station Buoy to Lower Gasper Light Vessel (166), N. 54° 00′ E., distance 1,760 yards. From 24 feet at the Station Buoy, deepens to 27 feet as it crosses to the L. G. Light Vessel.

175. **The Thornhill's Patch Buoy.** Second class, iron, painted red, surmounted with red basket beacon and marked T. P. in white. Is intended as a western buoy, but at present in mid-channel in a narrow gut running up between the Middle Ground (352) on the east and the head or extension of the Eastern Sea Reef (342) on the west. Is in 21 feet, the shoalest part of the gut also the narrowest part.

176. From Thornhill's Patch Buoy to Lower Thornhill's Buoy (162), N. 58° 45′ W., distance 6,000 yards. From 21 feet at the L. T. Buoy, shoals gradually to 13 feet at one-fourth the distance, to 6 feet at half the distance on the Eastern Sea Reef Head (342), and then deepens off it to 2½ fathoms at the L. T. Buoy on the eastern side of the (now closed) Thornhill's Channel (346) and off the western edge of the Reef Head.

176*a*. From Thornhill's Patch Buoy to Upper Thornhill's Buoy (122), N. 12° 15′ W., distance 10,150 yards. From 21 feet at the T. P. Buoy, shoals to 19 feet at 1,000 yards off, and for some distance as it runs up along the eastern edge of the Eastern Sea Reef Head (342), which bulges out here until at two-fifths the distance, when the channel widens as this sand falls back; and deepens gradually to 21 feet again, as it runs up the western side of the gut, separating the head of the Middle Ground (352) (or Gasper Sand) from the Eastern Sea Reef Head, and close to the westward of 22 feet after it has run three-fourths the distance; deepening to 23 feet at the U. T. Buoy on the western side of the junction of Thornhill's (on the west)

and Gasper Channels (351 & 356) with the lower part of Saugor Roads (349), and just off the eastern edge of the tail of the Long Sand (341).

177. From Thornhill's Patch Buoy to Upper Gasper Light Vessel (127), N. 5° 30′ E., distance 10,200 yards. From 21 feet at the T. P. Buoy, deepens to 22 feet at 1,000 yards; shoals again to 21 feet at one-third the distance (when abreast the 6-feet patch and on which the rollers break, to the eastward, on the head of the Middle Ground (352) or Gasper Sand); as it strikes and skirts the western edge of this last named sand; shoals to 19 feet at two-thirds the distance, and at 1,000 yards from the U. G. Light Vessel; deepens to 20 feet, and to 21 feet at the Light Vessel on the western side of the head of the Gasper Channel (351). This line passes close to the U. *W.* G. Buoy (see 127).

178. From Thornhill's Patch Buoy to Centre Western Gasper Buoy (138), N. 18° 00′ E., distance 7,700 yards. From 21 feet at the T. P. Buoy, shoals gradually to 12 feet on the head of the Middle Ground (352) or Gasper Sand at two-fifths the distance, and when close to the N. W. edge of the 6-feet patch on which the sea breaks with violence; then gradually deepens to 19 feet at the C. *W.* G. Buoy on the western side of the Gasper Channel (351) as the line runs across the head of the Middle Ground or Gasper Sand.

179. From Thornhill's Patch Buoy to Lower Western Gasper Buoy (156), N. 50° 15′ E., distance 6,000 yards. From 21 feet at the T. P. Buoy, gradually shoals to 12 feet at one-fourth the distance, to 11 feet when half way and when 1,000 yards from the S. E. edge of the 6-feet patch on which the sea breaks; and at four-fifths the distance deepens to 12 feet; then rapidly deepens off the eastern edge of the Middle Ground (352) to 21 feet at the C. *W.* G. Buoy (138) as it crosses this last named sand to the buoy, just off its north-eastern edge and on the western side of the Gasper Channel (351).

180. From Thornhill's Patch Buoy to Gasper Light Station Buoy (172) East, 7,000 yards. From 21 feet at the T. P. Buoy, shoals to 15 feet at one-fourth the distance and to 12 feet at half way; deepens to 15 feet at three-fifths the distance, to 18 feet at four-fifths the distance, then rapidly to 24 feet at the *G*. S. Buoy as it crosses the Middle Ground (352) to this buoy, off its eastern edge and on the western side of the junction of Eastern and Gasper Channels (356 and 351).

181. **The Upper Saugor Sand Buoy.** Second class, wood. In 31 feet, and on account of the recession of Saugor Sand (355), now (1880) 2,000 yards west of 23 feet on the western edge of this sand: marks, so far, the eastern limits of the Eastern Channel (356). Is painted black and marked U. S. S. in white, and surmounted with a black ball beacon.

182. From Upper Saugor Sand Buoy to Thornhill's Patch Buoy (175), N. 85° 45′ W., distance 12,200 yards. From 31 feet at the U. S. S. Buoy, gradually shoals across the Eastern Channel (356) to 24 feet on the eastern edge of the Middle Ground (352) at two-fifths the distance, to 12 feet at three-fourths the distance; gradually deepening, from this, the shoalest part, off the western side of the Middle Ground to 15 feet at 2,000 yards, and to 21 feet at the T. P. Buoy, in mid-channel in the gut running up between this latter sand and the Eastern Sea Reef Head

183. From Upper Saugor Sand Buoy to Gasper Light Station Buoy (172), N. 74° 40′ W., distance 5,600 yards. From 31 feet at the U. S. S. Buoy, gradually shoals across the Eastern Channel (356) to 24 feet at the *G*. S. Buoy on the western limits of the junction of the Gasper and Eastern Channels (351 and 356) and off the eastern edge of the Middle Ground (352).

184. From Upper Saugor Sand Buoy to Lower Gasper Light Vessel (166), N. 57° 30′ W., distance 4,680 yards. From 31 feet at the U. S. S. Buoy, gradually shoals to 27

feet at the Lower Gasper Light Vessel, as it runs up and across the Eastern Channel (356).

185. From Upper Saugor Sand Buoy to Dooblat Grove (77), N. 10° 00′ W., distance $11\frac{3}{4}$ miles. From 31 feet at the U. S. S. Buoy, gradually shoals to 23 feet at half the distance, to 18 feet at three-fifths the distance, to 11 feet at two-thirds the distance, to 10 feet at four-fifths the distance, or at about 3,500 yards from the Grove, and to 9 feet at twice the distance from the Grove to the beach from this point, or about 1,200 yards from low water mark; strikes the white sandy beach, and thence to the Grove on the south end of Saugor Island (350).

186. From Upper Saugor Sand Buoy to Seyer Point (353), N. E. by N. $\frac{1}{2}$ N., distance $8\frac{1}{2}$ miles. From 31 feet at the U. S. S. Buoy, shoals to 25 feet at 2,000 yards, and then rapidly to 6 feet, 100 yards further on to Saugor Sand (355), as it strikes its steep western edge; just skirts the tail of the dry Edmonstone Sand (354), on which the sea breaks heavily; crosses the head of Saugor Sand, and at four-fifths the distance deepens suddenly from 2 fathoms to 5 fathoms, and then to 8 fathoms midway across this channel, the entrance to the Barratulla River or Channel Creek (see 250 and 353): and so on in deep water right over to Seyer Point, on which are some tall trees.

187. **The Western Reef Head Passage Buoy.** Second class, wood, painted white with red apex, marked R. H. P. in black, and surmounted with a red yard. ~~In~~ $2\frac{3}{4}$ fathoms off the extreme tail of the Long Sand (341) and marking the northern limit (or as a western buoy to) of the Reef Head Passage (345), at its junction with the Western Channel (343); and also, with the eastern R. H. P. Buoy (190) to the S.S.E. of it, serving as an eastern buoy for this last named channel; but as Thornhill's Channel (346) is closed now, these two buoys are only useful as marks for the Western Channel.

188. From Western Reef Head Passage Buoy to Upper Middle Ground Buoy (153) (of Western Channel), N. 63°

15′ W., distance 11,300 yards. From $2\frac{3}{4}$ fathoms at the R. H. P. (*W.*) Buoy, shoals to $2\frac{1}{2}$ as it cuts across the tail of the Long Sand (341) at half a mile distance, but deepens again off its western edge to $5\frac{1}{8}$ at one-fifth the distance: carrying this water till within 1 mile of the U. M. G. Buoy, then shoaling to $4\frac{1}{4}$ at the buoy, off the eastern edge of the northern end of the Western Channel Middle Ground (217) and on the western side of the Western Channel (343).

189. From Western Reef Head Passage Buoy to J Buoy (148), N. 45° 00′ W., distance 11,300 yards. From $2\frac{3}{4}$ fathoms at the R. H. P. (*W.*) Buoy, shoals to $2\frac{1}{4}$ fathoms three-fourths of a mile off, on the extreme tail of the Long Sand (341), then deepens off its western edge into $5\frac{1}{6}$ fathoms at a quarter the distance; shoaling gradually to $4\frac{3}{4}$ fathoms at three-fourths the distance, and to $3\frac{3}{4}$ fathoms at the J Buoy, now almost in mid-channel, 2 miles to the westward of the western edge of the Long Sand, and $1\frac{1}{4}$ miles to the S.S.W. of a prong of that sand; painted as an eastern buoy for the Western Channel (343).

190. **The Eastern Reef Head Passage Buoy.** Second class, wood, painted black, marked R. H. P. in white, and surmounted with a black triangular beacon (not visible when end on). In 3 fathoms, off the western edge of the Eastern Sea Reef Head (342), and on the sides of the now closed Reef Head Passage (345) and of the Western Channel (343).

191. From the (Eastern) Reef Head Passage Buoy to the Upper (Western Channel) Middle Ground Buoy (153), N. 57° 40′ W., distance 12,450 yards. From 3 fathoms at the R. H. P. (E). Buoy, deepens to $5\frac{1}{4}$ fathoms at quarter the distance, and to $5\frac{1}{2}$ fathoms at half the distance; shoaling to $4\frac{3}{4}$ fathoms at four-fifths the distance, and to $4\frac{1}{4}$ fathoms at the U. M. G. (Western Channel) Buoy: on the western limits of the Western Channel (343) and off the eastern edge of the northern end of the Western Channel Middle Ground (217), as the line runs up and across this channel.

192. From the (Eastern) Reef Head Passage Buoy to the (Western) Reef Head Passage Buoy (187). From 3 fathoms at the R. H. P. (*E.*) Buoy, deepens to three and a quarter fathoms when near the R. H. P. (*W.*) Buoy, then shoals to 2¾ fathoms at this buoy, on the N. N. Western side of the Reef Head Passage (345) and off the tail of the Long Sand (341), as the line runs across the entrance to the Reef Head Passage (now closed).

193. From Eastern Reef Head Passage Buoy to Thornhill's Patch Buoy (175), N. 66° 30′ E., distance 7,800 yards. From 3 fathoms at the R. H. P. (East) Buoy, shoals to 2 fathoms at half a mile on the western edge of the Eastern Sea Reef Head (342), and to 1½ fathoms at one-third the distance; deepening off the eastern edge of this Reef Head to 3 fathoms; and after shoaling again on the prong close to, at a quarter of a mile from the T. P. Buoy, deepens from 2 fathoms till 3½ fathoms is reached at the Buoy, in the centre of the narrowest and shoalest part of the gut running up between the Eastern Sea Reef Head and the Middle Ground (352).

194. **The Lower Middle Ground Buoy (Eastern Channel).** Second class, wood, painted red, marked L. M. G. in white, and surmounted with a red basket beacon. In 25 feet, just off the eastern edge of the Middle Ground (352) and on the western limits of the Eastern Channel (356).

195. From Lower Middle Ground Buoy (Eastern Channel) to Eastern Reef Head Passage Buoy (190), N. 77° 45′ W., distance 16,800 yards. From 25 feet at the L. M. G. Buoy, shoals on to the eastern edge of the Middle Ground (352), gradually to 19 feet at 2,000 yards, and to 16 feet at 3,000 yards, the shoalest; then gradually deepens off its western edge and into the channel at the back of it, to 24 feet when half-way and when the T. P. Buoy bears N. by W.; gradually shoaling again on the Eastern Sea Reef Head (442), on the western side of it, to 19 feet at three-fourths the distance, and on the Reef Head to less than 2 fathoms;

deepening off its western edge from 2½ fathoms to 3 fathoms and so on to the (Eastern) R. H. P. Buoy, on the eastern side of the Western Channel (343) and also Reef Head Passage (345).

196. From Lower Middle Ground Buoy (Eastern Channel) to Thornhill's Patch Buoy (175), N. 54° 45′ W., distance 11,400 yards. From 25 feet at the L. M. G. Buoy, shoals gradually on to the eastern edge of the Middle Ground (352) to 19 feet at one-fifth the distance and to 13 feet at two-fifths the distance; then gradually deepens again to 19 feet at three-fourths the distance on the western edge of this sand, and to 21 feet at the T. P. Buoy, in the constricted and shoalest part of the channel running up between it and the Eastern Sea Reef Head (342): as the line strikes diagonally up and across the Middle Ground (352).

197. From Lower Middle Ground Buoy (Eastern Channel) to Gasper Station Buoy (172), N. 21° 00′ W., distance 7,250 yards. From 25 feet at the L. M. G. Buoy, runs into 24 feet at a quarter the distance, and carries that depth right on to the S'n Buoy, on the eastern edge of the Middle Ground (352) and on the western limits of the junction of Gasper with Eastern Channel (351 and 356), as it runs up along the eastern edge of the Middle Ground. This line must not be borrowed upon, as there is always a swell running up the Middle Ground when there is little or none elsewhere.

198. From Lower Middle Ground Buoy (Eastern Channel) to Lower Gasper Light Vessel (166), N. 8° 45′ W., distance 7,900 yards. From 25 feet at the L. M. G. Buoy, gradually deepens to 27 feet at three-fifths the distance, and continues that to the L. G. Light Vessel, at the junction of Gasper and Eastern Channels (351 and 356): as it strikes up and out into the Eastern Channel (356) to the vessel.

199. From Lower Middle Ground Buoy (Eastern Channel) to Upper Saugor Sand Buoy (181), N. E. by N. ½ N., distance 5,433 yards. From 25 feet at L. M. G. Buoy, gradually deepens as it strikes up and across the Eastern

Channel (356) to 31 feet at the U. S. S. Buoy, 2,000 yards west of the western edge of Saugor Sand (355) and on the eastern side of the Eastern Channel (or rather, of mid channel).

200. **The Western Channel Spit Buoy.** Second class, iron, painted black with white apex, marked S. in white, and is surmounted with a black open basket. In 5¾ fathoms, half a mile to westward of 3½ fathoms, on the steep western edge of the Eastern Sea Reef (342); and on the eastern limits of the Western Channel (343).

201. From Western Channel Spit Buoy to Centre Middle Ground Buoy (Western Channel) (215), N. 71° 30′ W., distance 12,890 yards. From 5¾ fathoms at the S. Buoy, first deepens to 6 fathoms, and then gradually shoals as it strikes diagonally across the Western Channel (343) to 3½ fathoms at the C. M. G. Buoy, on the eastern edge of the Western Channel Middle Ground (217), and on the western limits of the Western Channel.

202. From Western Channel Spit Buoy to Upper Middle Ground Buoy (Western Channel) (153), N. 57° 30′ W., distance 19,400 yards. From 5¾ fathoms at the S. Buoy, first deepens to 6 fathoms as the last line, and then carries from 5½ to 5¼ for four-fifths the distance; then shoals to 4¼ fathoms at the U. M. G. Buoy, off the eastern edge of the head of the Western Channel Middle Ground (317), and on the western limits of the Western Channel (343), as the line strikes up and across this channel.

203. From South or Western Channel Spit Buoy to Eastern Reef Head Passage Buoy (190), N. 7° 30′ W., distance 8,850 yards. From 5¾ fathoms at the S. Buoy, gradually shoals to 4 fathoms at half the distance, where it cuts the steep western edge of the Eastern Sea Reef (342) as it bulges out here; and then shoals on to the R. H. P. (East) Buoy, in 3 fathoms, off its western edge, and on the eastern limits of the Western Channel (343), as the line runs up the steep western edge of the Eastern Sea Reef.

204. From South Channel Spit Buoy to Thornhill's Patch or Prong Buoy (175), N. 26° 00′ E., distance 13,150 yards. From 5¾ fathoms at S. Buoy, shoals to 3 fathoms on the steep western edge of the Eastern Sea Reef (342), and to 10 feet at one-third the distance, on the centre of the Reef; then gradually deepens to 3 fathoms on the eastern edge of the Eastern Sea Reef at three-fourths the distance; and deepens to 22 feet, 1½ miles from the T. P. Buoy, but shoals at this buoy to 21 feet, in centre of the constricted and narrow channel running up to the lower part of Saugor Roads (349), between the Eastern Sea Reef Head and the Middle Ground (352): as the line crosses this Reef and runs up this last mentioned channel.

205. From South or Western Channel Spit Buoy to Eastern Channel Lower Middle Ground Buoy (194), N. 70° 50′ E., distance 8½ miles. From 5¾ fathoms at S. Buoy, shoals immediately on the steep western edge of the Eastern Sea Reef (342) to 3½ fathoms half a mile off; crosses this reef or sand in 11 feet; deepening to 19 feet on its eastern edge at two-fifths the distance, to 27 feet in the centre of the disused channel between the Eastern Sea Reef and the Eastern Channel Middle Ground (352), at half the distance; then shoaling to 18 feet on the western edge of this Middle Ground at three-fourths the distance; crosses it in (least water) 17 feet, at 3,000 yards from the L. M. G. Buoy; gradually deepening off it to the buoy, in 25 feet, off its eastern edge and on the western limits of the Eastern Channel (356).

206. **The Centre Saugor Sand Buoy.** First class, iron, painted black, marked C. S. S. in white, and surmounted with a black ball beacon. In 35 feet 1,100 yards off 20 feet on the steep western edge of Saugor Sand (355), and 1,500 yards to the westward of 9 feet on this Sand and on the eastern limits of the Eastern Channel (356).

207. From Centre Saugor Sand Buoy to Lower Middle Ground Buoy (Eastern Channel) (194), N. 51° 15′ W.,

distance 10,600 yards. From 35 feet at the C. S. S. Buoy, deepens to 39 feet at 1,000 yards from it, and then gradually shoals, as the line runs diagonally up and across the Eastern Channel (356), to 25 feet at the L. M. G. Buoy (Eastern Channel), on the western limits of the Eastern Channel and off the eastern edge of the Middle Ground (352).

208. From Centre Saugor Sand Buoy to Upper Saugor Sand Buoy (181), N. 24° 45′ W., distance 13,120 yards. From 35 feet at the C. S. S. Buoy, gradually deepens to 38 feet at one-third the distance (to the eastward of which and nearer the steep edge of Saugor Sand (355) there is 39 feet), gradually shoaling to 31 feet at the U. S. S. Buoy two-fifths the distance across the Eastern Channel (356) from the steep western edge of Saugor Sand; as this line runs up and out into the Eastern Channel: deeper water by 1 and 2 feet being found between this line and the steep western edge of Saugor Sand.

209. **The Bell Buoy.** A large size, specially built buoy, with bell and red basket beacon, when it is in position: but at present, represented by a second class wooden, red basket beacon buoy; painted red and white in vertical sections, and marked B E L L in white. In 24½ feet off the eastern edge of the tail of the Middle Ground (352) and on the western limits of the Eastern Channel (356), which, below this buoy, widens to double the width which it has above it, as this buoy is about midway of the C. S. S. Buoy and the (Eastern Channel) Spit Buoy (234). A very heavy sea runs hereabouts, often breaking violently during bad weather; which is avoided by keeping more to the eastward in deep water. There is 21½ feet across the tail of the Middle Ground abreast this buoy.

210. From Bell Buoy to Western Channel Spit Buoy (200), N. 78° 00′ W., distance 16,100 yards. From 24½ feet at the Bell Buoy, shoals on the tail of the Middle Ground (352) to 21 feet at 2,000 yards distant; then deepens off the western edge of it till in 28 feet in mid

channel, in the channel running up between the Middle Ground and Eastern Sea Reef (342), at two-fifths the distance; then shoals gradually to 12 feet on the centre of the Eastern Sea Reef at four-fifths the distance; deepening suddenly off the western edge of the Eastern Sea Reef to 5¾ fathoms at the S. Buoy, half a mile from 3½ fathoms on its edge and on the eastern limits of the Western Channel (343).

211. From Bell Buoy to Thornhill's Patch or Prong Buoy (175), N. 33° 20′ W., distance 18,100 yards. From 24½ feet at the Bell Buoy, shoals gradually as it runs up and across the Middle Ground (352) to 19 feet at half the distance; 1,000 yards to the eastward of which point there is only 17 feet in the centre of the Middle Ground; it then gradually deepens to 23 feet at three-fourths the distance; and shoals to 21 feet at the T. P. Buoy, in the centre of the constricted and shoal part of the channel running up to the lower part of Saugor Roads (349), between the Middle Ground and the Eastern Sea Reef Head (342).

212. From Bell Buoy to Lower Middle Ground Buoy (Eastern Channel) (194), N. 4° 45′ W., distance 8,550 yards. From 24½ feet at the Bell Buoy, shoals to 24 feet as it runs up along the eastern edge of the Middle Ground (352), and deepens to 25 feet at four-fifths the distance, carrying that depth to the L. M. G. Buoy, just off the eastern edge of the Middle Ground and on the extreme western limits of the Eastern Channel (356). Deep vessels must not borrow to the westward of this line, as a heavier swell runs here, on the tail of the Middle Ground, than anywhere else. Vessels have struck the ground here in 9 feet more than their draught.

213. From Bell Buoy to Upper Saugor Sand Buoy (181), N. 8° 45′ E., distance 13,950 yards. From 24½ feet at the Bell Buoy, gradually deepens to 31 feet at half the distance, and carries that water to the U. S. S. Buoy, a little to the eastward of the centre of the Eastern Channel (356), or about one-third the distance across it,

from the steep western edge of Saugor Sand (355) on the eastern side of the channel.

214. From Bell Buoy to Centre Saugor Sand Buoy (206), N. 76° 15′ E., distance 7,850 yards. This line runs at right angles across the course of the Eastern Channel (365), and is a measure of the width of the channel at this part. From 24½ feet at the Bell Buoy, gradually deepens to 34 feet at half the distance and to 39 feet at four-fifths the distance; shoaling to 35 feet at the C. S. S. Buoy, on the eastern limits of the Eastern Channel (356), half a mile to the westward of 23 feet on the steep western edge of Saugor Sand (355) and 1¼ miles from 9 feet only, on Saugor Sand; and which 9-foot line of soundings runs down for two miles from abreast the C. S. S. Buoy.

215. **The Western Channel Centre Middle Ground Buoy.** Second class, wood, painted white, marked C. M. G. in black, and surmounted with red open basket beacon. In 3½ fathoms off the eastern edge of the Western Channel Middle Ground (217), and on the western limits of the Western Channel (343).

216. From Western Channel Centre Middle Ground Buoy to Western Brace Buoy (111), N. 55° 00′ W., distance 16¾ miles. From 3½ fathoms at the C. M. G. Buoy, shoals at once on the Western Channel Middle Ground (217) to 3¼ fathoms; then deepens to 4 fathoms off its western edge at 1½ miles from the C. M. G. Buoy; deepens to 5 fathoms in the centre of the channel running between the eastern edge of the Western Sea Reef Head (336) and western edge of the Western Channel Middle Ground; shoals to 4 fathoms on the eastern edge of the Western Sea Reef Head at one-fourth the distance, or at about 4 miles; shoals to 2¼ fathoms on this Reef Head, and crossing 2¼ miles over this Reef, deepens on its western edge to 3 fathoms at two-fifths the distance; and to 3¼ fathoms in the channel separating this Reef Head from the tail of the Eastern Brace (335); shoaling again to 3 fathoms on the eastern edge of the Eastern Brace, or about 1⅗ miles

from 3 fathoms on the other side of the channel as the line crosses it diagonally; shoals to 2¼ fathoms at half the distance on the Eastern Brace, and carries from 2¼ to 2½ fathoms right across it as it runs diagonally over for a distance of 5¼ miles, when it deepens to 3 fathoms on the western edge of this Brace and on the eastern limits of the channel (here over 4 miles wide) separating the two Braces, or at about three-fourths the distance; deepens quickly to 4¼ fathoms after leaving the western edge of the Eastern Brace, and then gradually shoals, as it runs obliquely across this channel, to 17 feet at the W. B. Buoy, on its western limits, and just off the eastern edge of the Western Brace (331).

217. From Western Channel Centre Middle Ground Buoy to Western Channel Upper Middle Ground Buoy (153), N. ½ W., distance 5¾ miles. From 3½ fathoms at the C. M. G. Buoy, gradually deepens to 4 fathoms half way and to 4¼ fathoms at the U. M. G. Buoy, as this line runs up along, whilst enclining away from, the eastern edge of the Western Channel Middle Ground (217) to this last named buoy: which is half a mile to the eastward of the eastern edge of this sand, and on the western limits of the Western Channel (343), which this line also defines.

218. From Western Channel Centre Middle Ground Buoy to Eastern Reef Head Passage Buoy (190), E. N. E., distance 5⅗ miles. From 3½ fathoms at the C. M. G. Buoy, deepens to 5½ fathoms at one-fourth the distance, to 5¾ at half the distance; and then gradually shoals to 3 fathoms at the Eastern R. H. P. Buoy, just off the western edge of the Eastern Sea Reef (342), and on the eastern limits of the Western Channel (343): as this line runs across, and measures the breadth of, this channel.

219. **The Western Channel Lower Middle Ground Buoy.** Second class, wood, painted red and white in alternate vertical sections, red apex; marked L. M. G. in black; and surmounted with red open basket beacon. In 4¾ fathoms, well off and to the S.E. of the tail end of

the Western Channel Middle Ground (217), and on the western side of the junction of Western and South Channels (343 and 344). The rise of tide on F. and C. days is 12 feet here.

220. From Western Channel Lower Middle Ground Buoy (in 4¾ fathoms) to 4½ fathoms on the tail of the Western Brace (331). West, distance 16 miles. From 4¾ fathoms at the L. M. G. Buoy, shoals to 4½ fathoms, at three-quarters of a mile distance, on the tail of the Western Channel Middle Ground (317); deepens to 6¼ fathoms in mid channel in the channel running between the last named sand and the Western Sea Reef (336) (here, from 4 fathoms to 4 fathoms, 2¾ miles broad); shoals again to 4 fathoms on the eastern edge of the Eastern Brace (335) (here 3½ miles broad) at one-fourth the distance and to 2½ fathoms on its centre; then deepens to 4 fathoms on its western edge at three-eighths the distance, and on the eastern limits of the *old* swatchway (here from 4 fathoms to 4 fathoms, nearly 8 miles broad) running up between the Western Reef and Eastern Brace; deepening to 8 fathoms 1½ miles from this last point on the western edge of the Western Sea Reef, or about five-eighths the distance; it then gradually shoals across this last mentioned channel to 4½ fathoms on the tail of the Western Brace. [*See* Swatchway (338).]

221. From Western Channel Lower Middle Ground Buoy to 4½ fathoms on the tail of the Eastern Brace (335), N.W. by W. ½ W., distance 12¼ miles. Shoals from 4¾ fathoms at the L. M. G. Buoy to 4 fathoms at 1 mile distance, on the tail of the W. C. Middle Ground (217); deepens gradually to 6 fathoms in mid channel in the channel running between the W. C. Middle Ground and Western Sea Reef (336); then shoals to 4 fathoms on the eastern edge of this Reef at half way, and to 2¼ fathoms on the centre of Reef; deepening again to 4 fathoms on its western edge at four-fifths the distance, and on the eastern limits of the channel between the Western Sea

Reef Head and tail of Eastern Brace, here 2½ miles broad; gradually deepening to 6 fathoms in mid channel; and shoaling to 4½ fathoms on the tail of the Eastern Brace.

222. Between the two last given lines, a line from Western Channel Lower Middle Ground Buoy to Balasore Buoy (224) runs W. by N. ¼ N., distance 45½ miles; carrying 2¼ fathoms across the Western Sea Reef (336), and 3½ fathoms across the Western Brace (331); gradually deepening to 6¾ fathoms, 2¼ miles to the westward of it: and carries this water till half way between it and the Balasore Buoy; then gradually shoals to 19 feet at this buoy, 4 miles from the nearest dry land and on the N.W. segment of Balasore Roads (332). On this line, and when half way between the western edge of the Western Brace and Balasore Buoy, there is a remarkable patch of soundings of mud with shells and *sea-eggs*.

223. From Western Channel Lower Middle Ground Buoy to Western Channel Spit Buoy (200), N. 47° 10′ E., distance 8,700 yards. From 4¾ fathoms at the L. M. G. Buoy, deepens to 6 fathoms half way, and continues at that depth till close to the S. Buoy; shoaling to 5¾ fathoms at this buoy off the western edge of the Eastern Sea Reef (342) and on the eastern limits of the junction of Western and South Channels (343 and 344), as the line runs diagonally up across the Western Channel.

224. **The Balasore Buoy.** Second class, wood, painted black, marked with an anchor in white, and surmounted with a black basket beacon. In 19 feet on the edge of the extensive flat bordering the whole of the shore of the Roads (332), 4 miles from the nearest dry land at Chandipore, and on the N. Western limits of Balasore Roads. The northernmost of the Nilgheri Hills bear from this Buoy W.N.W., 19¼ miles, and the southernmost W. ⅛ S., 22½ miles.

225. From Balasore Buoy to the mouth of the Boorabullung River, on the right bank of which stands the town of Balasore, about 5 miles inland from the beach,

N.W. by N. $\frac{1}{4}$ N., distance $4\frac{1}{2}$ miles. From 19 feet at Balasore Buoy, shoals gradually on to the beach as it runs in across the Mud Flat.

226. From Balasore Buoy to the Centre of Pipley Sand (330), off the mouth of the Soobunreekah River. N.E. by E., distance 16 miles. From 19 feet at the Balasore Anchoring Buoy, shoals to 18 feet half way as it edges in on the flats and gradually shoals to the dry edge of Pipley Sand.

227. From Balasore Buoy to Western Brace Buoy (111), N. 73° 00′ E., distance 31 miles. From 19 feet at the Balasore Anchoring Buoy, deepens to $4\frac{1}{2}$ fathoms at 7 miles distance; shoaling to 4 fathoms when half way and abreast the Pipley Sand (330); after which it deepens again to $4\frac{1}{2}$ fathoms at about three-fourths the distance, and then gradually shoals on to the western edge of the Western Brace (331) in 4 fathoms at $4\frac{1}{2}$ miles from the W. B. Buoy, and to $1\frac{3}{4}$ fathoms on the Western Brace, 1 mile from it; deepening again to 17 feet at this buoy, off its eastern edge and on the western limits of the, here, narrowing gut or channel separating the two Braces (331 & 335).

228. **The South Channel Reef Buoy.** Second class, wood, painted black with white apex, marked S. C. R. in white, and surmounted with a black open basket beacon. In 36 feet just off the western edge of the Eastern Sea Reef (342) and on the eastern limits of the South Channel (344).

229. From South Channel Reef Buoy to 5 fathoms on the tail of the Western Brace (331). West, distance 20 miles. From 6 fathoms at the S. C. R. Buoy, deepens to $6\frac{1}{2}$ fathoms a short distance away, and then shoals to 5 fathoms at one-fourth the whole distance, or two-thirds the distance across the South Channel (344), on the extension of the Western Channel Middle Ground (217); then deepens to $6\frac{1}{4}$ fathoms at one-third the distance; then shoals quickly to $4\frac{1}{4}$ fathoms on the eastern edge of the Western Sea Reef (336), 8 miles from the S. C. R. Buoy (which is the width

of the channel here); shoals to 3¼ fathoms on the central part of this Reef; deepens to 4 fathoms on the western edge of the Western Sea Reef (which is 3¼ miles across from 4 fathoms to 4 fathoms), and on the western side of the channel (here 8 miles broad) running up between the Western Brace to the westward and the Western Sea Reef and the Eastern Brace (335) to the eastward; deepening rapidly from 4 to 6 fathoms off this Reef, and then to 8¼ fathoms 1¾ miles to the westward of the 4 fathoms last given: then it shoals gradually across this channel to 5 fathoms on the tail of the Western Brace. [*See* Swatchway or Kell (338).]

230. From South Channel Reef Buoy to Western Channel Lower Middle Ground Buoy (219), N. 65° 30′ W., distance 10,850 yards. From 6 fathoms at S. C. R. Buoy, deepens half a mile off to 6½ fathoms; then shoals gradually to 4¾ fathoms off the S.E. edge of the tail of the Western Channel Middle Ground (217) to the L. M. G. Buoy, marking the western limits of the junction of the Western (343) with the South Channel (344) as the line runs across the channel obliquely. On this line there is considered to be 12 feet rise of tide on F. and C. days.

231. From South Channel Reef Buoy to Western Channel Spit Buoy (234), N. 18° 45′ W., distance 10,950 yards. From 6 fathoms at the S. C. R. Buoy, gradually shoals to 5¾ fathoms at the S. Buoy, off the western edge of the Eastern Sea Reef (342), and on the eastern limits of the junction of the Western and South Channels (343 & 344), as the line runs up along and parallel to the western edge of the Eastern Sea Reef, being the eastern limiting line for the last named channels.

232. From South Channel Reef Buoy to Eastern Channel Spit Buoy, N. 45° 43′ E., distance 4,800 yards. From 6 fathoms at the S. C. R. Buoy, shoals quickly on the western edge of the Eastern Sea Reef (344) to 18 feet at 3,000 yards off, as the line strikes up and across the Reef, and to 15 feet at two-fifths the distance (the shoalest); then

deepens gradually to 22 feet at the (E. C.) S. Buoy, just off the eastern edge of the Eastern Sea Reef and on the western limits of the Eastern Channel (356).

233. From South Channel Reef Buoy to Bell Buoy (209), N. 60° 00′ E., distance 10,180 yards. From 6 fathoms at the S. C. R. Buoy, shoals quickly on the western edge of the Eastern Sea Reef (342) to 18 feet at 2,500 yards off, and to 15 feet (shoalest water) on the centre of the Reef as the line strikes obliquely up and across it; deepening to 18 feet on its eastern edge at one-fifth the distance, to 24 feet at one-third the distance, and 28 feet (deepest water) at three-eighths the distance, in the Eastern Channel (356), and off the entrance to the channel running up to Saugor Roads (349) between the Eastern Sea Reef and Middle Ground (352); shoaling again to 24 feet on the tail of the (E. C.) Middle Ground; then deepening to 24½ feet at the B E L L Buoy on the eastern edge of the tail of this Middle Ground and on the western limits of the Eastern Channel.

234. **The Eastern Channel Spit Buoy.** Second class, wood, painted red, marked S. in white, and surmounted with a red basket beacon. In 23 feet just off the eastern edge of the Eastern Sea Reef (342) and on the western limits of the Eastern Channel (356).

235. From (E. C.) Spit Buoy to (W. C.) Spit Buoy (200), N.W. ½ W., distance 5⅜ miles. From 23 feet at the (E. C.) Spit Buoy, shoals gradually to 12 feet in the centre of the Eastern Sea Reef (342) as the line runs up and across it; it then deepens again to 4 fathoms on the western edge of the Reef, and then quickly to 3½ fathoms at the (W. C.) Spit Buoy, a little distance (half a mile) off the western edge of the Eastern Sea Reef, and on the eastern limits of the Western Channel (343).

236. From (E. C.) Spit Buoy to Thornhill's Patch Buoy (175), N. ½ W., distance 9¼ miles. From 23 feet at the (E. C.) Spit Buoy, gradually deepens to 25 feet with the Bell Buoy (209), bearing east, as the line skirts along, and,

at the same time edges off the eastern edge of the Eastern Sea Reef (342), and when about one-fourth the distance; and afterwards varying from 25 to 27 feet till in 24 feet at three-fourths the distance, then gradually shoals to 21 feet at the T. P. Buoy, in the centre of the shoalest and most constricted part of the channel between the Middle Ground (352) and Eastern Sea Reef Head. This line marks the western limits of this channel and its junction with the Eastern Channel (356) to the southward of it.

237. From the (E. C.) Spit Buoy to the Bell Buoy (209), E.N.E., 10,300 yards. From 23 feet at the (E. C.) Spit Buoy, gradually deepens to 28 feet (the deepest) at one-third the distance; and then shoals again as it approaches the tail of the (E. C.) Middle Ground (352) to 23 feet 1½ miles from the B E L L Buoy, as the line crosses this last-mentioned sand; deepening to 24½ feet at this buoy, on the western limits of the Eastern Channel (356) and off the eastern edge of the tail of the (E. C.) Middle Ground. This line forms the north-western limit of the Eastern Channel, which is narrowed to this extent at the BELL Buoy, or about three-fifths its breadth below it.

238. **The Intermediate Light Vessel.*** A three-masted vessel of about 300 tons, with a yard on foremast only, mastheads and yard painted white, hull painted yellowish clay colour, and marked on her sides in 18-inch letters, INTERMEDIATE, in black, on a white ground. By day her signal of being in her proper position is two conical shapes with their points upwards, the one above the other, at the mainmast, or lantern masthead, which are struck in the event of the vessel driving out of

* Since the above was written, the following information concerning this Light, by S. Reid, River Surveyor, has been issued under date the 28th March, 1881:—The Intermediate Light Vessel is moored in 42 feet mud, in Lat. 21° 14′ N., Long. 88° 11′ 20″ E., and the following are bearings and distances from it: Intermediate Station Buoy, S. 45° E., 1¼ miles. Bell Buoy, N. 44° W., 5 miles. Centre Saugor Sand Buoy, north 4¼ miles.

her proper position. By night, her signal of being in her proper position is one bright fixed dioptric light at the main and the authorised riding light on the forestay, which are both hauled down in the event of the vessel driving off her station, and the proper signal shown, *viz.*,—a red light at each end and burns a red flare-up every quarter of an hour. In the event of an accident to this vessel, and she is compelled to quit the station, her place is taken up by a reserve pilot brig: which flies a red St. George's Cross on a white ground at the main, by day; and, by night, shows two bright lights, one at each main-topsail yard arm, and a light on the forestay to indicate the direction her head is in. She is in position from the 1st of February to the 30th of November, both days inclusive. She is moored in 43½ feet, in latitude 21° 14′ N., longitude 88° 11′ 30″ E., 4,000 yards to the westward of 23 feet on the western edge of Saugor Sand (355), in the Eastern Channel (356), and half way, or intermediate, between the Lower Gasper Light (166) and the Eastern Channel Light Vessel (486). Her light is 48 feet high, and like all the other lights, shines most powerful when seen just above the horizon; then is the best time, by lowering the eye a few feet, and dipping the light, to make sure it is not a vessel's common regulation, anchor, or steamer's masthead light, which is in sight. [During the two months that this Light Vessel will be removed from her station, December and January, the Lower Gasper Light will burn a blue light, not only at the half-hour intervals, but also at the hour; so that every following half hour a blue light will indicate her whereabouts, and that she is in proper position: and the glare of these blue lights are seen at a distance of sometimes over 30 miles, 20 miles beyond the radius of the lights.] High water, full and change, at this station at 9h. 18m. Rise of tide, springs, 12 feet; neaps, 10 feet.

239. From Intermediate Light Vessel to (E. C.) Spit Buoy (234), N. 80° 00′ W., distance 16,550 yards. From 43½ feet at the Intermediate Light Vessel, gradually shoals

across the Eastern Channel (356) to 30 feet at one-third the distance, to 28 feet at two-fifths the distance, on the extension of the tail of the Middle Ground (352) (when the Bell Buoy bears North 2½ miles); deepens to 29½ feet at three-fifths the distance; then gradually shoals to 23 feet at the (E. C.) Spit Buoy, off the eastern edge of the Eastern Sea Reef (342) and on the western limits of the Eastern Channel.

240. From Intermediate Light Vessel to Bell Buoy (209), N. 44° 00′ W., distance 10,200 yards. From 43½ feet at the Intermediate Light Vessel, shoals gradually to 30 feet at two-thirds the distance, and to 24½ feet at the BELL Buoy, on the western limits of the Eastern Channel (356), and off the S.E. verge of the Middle Ground (352), as the line runs up and across the Eastern Channel.

241. From Intermediate Light Vessel to Lower Gasper Light Vessel (166), N. 22° 15′ W., distance 24,600 yards. From 43½ feet at the Intermediate Light Vessel, gradually shoals to 5 fathoms at half way, and to 27 feet at the Lower Gasper Light Vessel, as the line runs up the course of the Eastern Channel (356).

242. From Intermediate Light Vessel to Centre Saugor Sand Buoy (206), N. 1° 45′ E., distance 8,400 yards. From 43½ feet at the Intermediate Light Vessel, gradually shoals to 39 feet at three-quarters of a mile from the C. S. S. Buoy; then rapidly to 35 feet to this buoy, just off the steep western edge of Saugor Sand (355), and on the eastern limits of the Eastern Channel (356) as the line runs up and across the Eastern Channel.

243. From Intermediate Light Vessel to 3 fathoms on the tail of the Subtermooky or Lighthouse Sand; also to 3 fathoms on the tail of Bulcherry Sand: East, distance 16½ miles to the tail of the Lighthouse Sand; and East, 25 miles to the tail of the Bulcherry Sand. From 43½ feet at the Intermediate Light Vessel, deepens at three-quarters of a mile to 45 feet; then shoals gradually to 40 feet at 1½ miles, then rapidly into 30 feet on the steep western edge

of Saugor Sand (355), and to 17 feet (the least water) at 2¾ miles, on the western prong of Saugor Sand; then deepens to 27 feet in the gut between the two prongs at 4¾ miles; shoals to 21 feet on the eastern prong of Saugor Sand; deepening off its eastern edge and into Lacam's Channel to the eastward of this sand, to 6¾ fathoms at 11 miles distance, as it crosses this channel, which is here from 5 fathoms to 5 fathoms, 4¼ miles broad; shoaling gradually to 5 fathoms on the western edge of the tail of the Subtermooky or Lighthouse Sand, and then suddenly into 3 fathoms on its tail, at only half a mile from the 5-fathom line at 16½ miles from the Intermediate Light; it then deepens gradually as it leaves the eastern edge of the tail of this sand to 5 fathoms, at 2½ miles from 3 fathoms; deepens to 6⅛ fathoms on the eastern side of the channel separating the Subtermooky Sand on the west from the Bulcherry Sand on the east, here, from 5 fathoms to 5 fathoms, 3 miles broad, running up to the entrance to the Jumera River; and after shoaling to 5 fathoms on the eastern limits of this channel, shoals to 3 fathoms on the tail of the Bulcherry Sand at 1¼ miles from the 5-fathom line of soundings. This line extended 9 miles farther east, crosses the Roy Mutlah Sand in 4½ fathoms the least water.

244. **The Intermediate Light Station Buoy.** Second class, iron, painted black and white in vertical sections, marked I. in black, and surmounted with a black egg-on-end shaped basket beacon. In 45 feet, 7,300 feet west of 30 feet on the steep western edge of Saugor Sand (355), and well over on the eastern side of the Eastern Channel (356). Marks the station for the Intermediate Light in the event of her being driven off it.

245. From Intermediate Light Station Buoy to Intermediate Light Vessel (238), N. 45° 00′ W., distance 2,900 yards. From 45 feet at the I. Buoy, shoals to 43½ feet at the Intermediate Light Vessel.

246. From Intermediate Light Station Buoy to Centre Saugor Sand Buoy (206), N. 10° 45′ W., distance 10,866 yards.

From 45 feet at the I. Buoy, gradually shoals to 35 feet at the C. S. S. Buoy as it runs up and angles towards the steep western edge of Saugor Sand (355) to this buoy, on the eastern limits of the Eastern Channel (356).

247. **The Upper Reef Buoy.** Second class, wood, painted red, marked U. R. in white, and surmounted with a red open basket beacon. In 25 feet just off the eastern edge of the Eastern Sea Reef (342) and on the western limits of the Eastern Channel (356), here 9½ miles broad.

248. From Upper Reef Buoy to South Channel Reef Buoy (128), N. 44° 45′ W., distance 8,780 yards. From 25 feet at the U. R. Buoy, shoals in the centre of the Eastern Sea Reef (342) to 21 feet at half the distance, and to 20 feet at three-quarters the distance; deepening again gradually to 25 feet on the western edge of the Eastern Sea Reef, and rapidly to 36 feet at the S. C. R. Buoy, only 1,000 yards from this last point as the line runs diagonally across the reef to this buoy, off its western edge and on the eastern limits of the South Channel (344).

249. From Upper Reef Buoy to (E. C.) Spit Buoy (234), N. 16° 20′ W., distance 11,466 yards. From 25 feet at the U. R. Buoy, shoals gradually to 22 feet at half the distance; deepens to 23 feet at three-fifths the distance; shoaling again to 22½ feet, and then deepening to 23 feet at the (E. C.) Spit Buoy, off the eastern edge of the Eastern Sea Reef (342) and on the western limits of the Eastern Channel; (356) as the line runs up along the eastern edge of the Eastern Sea Reef, defining the western limits of the Eastern Channel between these buoys.

250. From Upper Reef Buoy to Bell Buoy (♈), N. 24° 40′ E., distance 16,166 yards. From 25 feet at the U. R. Buoy, gradually deepens to 30 feet at half the distance, and then gradually shoals to 24½ feet at the BELL Buoy, off the S.E. edge of the tail of the Middle Ground (352) and on the western limits of the Eastern Channel (356) as the line runs up and out into the Eastern Channel, and crosses the mouth of the gut or channel

running up between the Eastern Sea Reef Head (342) and the Middle Ground.

251. From Upper Reef Buoy to Centre Saugor Sand Buoy (206), N. 42° 00′ E., distance 20,480 yards. From 25 feet at the U. R. Buoy, deepens to 30 feet at one-fifth the distance, to 32 at one-fourth the distance; shoals to 30 feet at half the distance; deepens to 31 at three-fifths the distance; and deepens gradually to 39 feet at four-fifths the distance; shoaling again to 35 feet at the C. S. S. Buoy, just off the steep western edge of Saugor Sand and on the eastern limits of the Eastern Channel (356), as the line runs up and across this channel.

252. From Upper Reef Buoy to Intermediate Light Vessel (238), N. 68° 00′ E., distance 15,080 yards. From 25 feet at the U. R. Buoy, deepens to 29 feet at one-fourth the distance, to 32 feet half way, to 35 feet at three-fourths the distance, and to 43½ feet at the Intermediate Light Vessel: as the line runs up and out into the Eastern Channel (356) to this Light Vessel, on the eastern side of mid-channel.

253. From Upper Reef Buoy to Intermediate Light Station Buoy (244), N. 73° 00′ E., distance 15,600 yards. The soundings on this line are much the same as the last line given, only, a little deeper water when well out into the channel.

254. **The Lower Saugor Sand Buoy.** First class, iron, painted black, marked L. S. S. in white, and surmounted with a flat triangular beacon (not visible when end on). Moored in 46 feet, 1⅝ miles to the westward of 30 feet on the western edge of the tail of Saugor Sand (355), and on the eastern limits of the Eastern Channel (356); and is the outermost eastern buoy of this channel. Is in Lat. 21° 8′ 45″ N. and Long. 88° 14′ 30″ E.

255. From Lower Saugor Sand Buoy to Upper Reef Buoy (247), N. 77° 30′ W., distance 21,300 yards. From 46 feet at the L. S. S. Buoy, deepens to 50 feet at one-eighth the distance; shoals to 38 feet at half way, to 32 feet

at three-fourths the distance, then gradually shoaling to 25 feet at the U. R. Buoy, just off the eastern edge of the Eastern Sea Reef (342), and on the western limits of the Eastern Channel (356), as the line runs across it.

256. From Lower Saugor Sand Buoy to Intermediate Light Vessel (238), N. 33° 00′ W., distance 13,650 yards. From 46 feet at the L. S. S. Buoy, deepens to 50 feet at one-eighth the distance; then shoals gradually to 43½ feet at the Intermediate Light Vessel, as the line runs up the channel parallel to the edge of Saugor Sand (355) on its east, and passing one-fourth of a mile to the westward of the I Buoy (244).

257. From Lower Saugor Sand Buoy to Centre Saugor Sand Buoy (206), N. by W. ⅝ W., distance 11 miles. From 46 feet at L. L. S Buoy, shoals to 40 feet half way, and to 35 feet at the C. S. S. Buoy, as the line runs up along the steep western edge of Saugor Sand (355), and marking the eastern limits of the Eastern Channel (356) between these buoys. This line should not be passed when standing to the eastward, as the sand is very steep to.

258. From Lower Saugor Sand Buoy to 5 fathoms on the tail of Bulcherry Sand, E. ⅛ N., distance 24 miles. From 46 feet at the L. S. S. Buoy, shoals to 30 feet on the western edge of Saugor Sand (355) at 3,000 yards off, then gradually shoals across to 22 feet on the eastern prong of Saugor Sand (this line being far to the southward of the tail of the western prong); deepening to 5 fathoms on its eastern edge and on the western limits of Lacam's Channel, at one-third the distance; deepens to 7 fathoms in Mid-Lacam's Channel, here (from 5 fathoms to 5 fathoms) 6 miles broad; then shoals to 3¾ fathoms on the tail of the Subtermooky or Lighthouse Sand, which is 3 miles broad here; it then deepens to 6 fathoms as it crosses the channel of the Jumera River, here 2½ miles broad; then shoals to 5 fathoms on the tail of the Bulcherry Sand.

259. **The Western Sea Reef Buoy.** Second class, wood, painted white, with a red apex, marked W. S. R.

in black, and surmounted with a red open basket beacon. Moored in 5 fathoms off the eastern edge of the tail of the Western Sea Reef (336), in Lat. 21° 9′ 30″N., Long. 87° 53′ 35″ E., and on the western limits of the South Channel (344), which is here 8 miles across. From this buoy least water across the Western Sea Reef is 4¼ fathoms.

260. From Western Sea Reef Buoy to Balasore Anchoring Buoy (224), W. by N. ½ N., 46 miles. From 5 fathoms at the W. S. R. Buoy, shoals to 3¾ fathoms on the western side of the Western Sea Reef (336), and then deepens to 6, 7, 8, and 9 fathoms within 3½ miles; shoals to 7½ fathoms on the tail of the Western Brace (331) at one-fourth the whole distance, then to 7 fathoms; deepening to 9 fathoms as it passes it, at half the distance; then gradually shoals to 7 fathoms (where formerly a buoy was moored) in a patch of "mud with shells and *sea-eggs*," at one-third the distance, and about the centre of Balasore Roads (332); shoals to 5 fathoms, 4½ miles outside the Balasore Buoy; then to 19 feet at the buoy, on the edge of the extensive flat bordering the whole foreshore of Balasore Roads, and here, from this buoy to the shore, 3¾ miles broad.

261. From Western Sea Reef Buoy to Western Brace Buoy (111), N. W. by N., distance 27 miles. From 5 fathoms at the W. S. R. Buoy, shoals gradually to 2¼ fathoms at one-third the distance, as the line runs up and obliquely over the Western Sea Reef (336); deepens to 4 fathoms on the western edge of the Western Sea Reef at half the distance; then quickly to 6 fathoms, in the *old* Swatchway running up N.N.E., between the head of the Western Sea Reef and the eastern edge of the tail of the Eastern Brace (335), here (from 5 fathoms to 5 fathoms) 2 miles broad; shoals to 4 fathoms on the tail of the Eastern Brace at three-fifths the distance; shoals to 2¾ fathoms on it, and deepens to 4 fathoms on its western edge to 4 fathoms at three-fourths the distance; deepens soon to 5 fathoms, and then gradually shoals as it runs obliquely up and across the tapering channel separating the Eastern and Western

Braces (831); here (from 5 fathoms to 5 fathoms) nearly 4 miles broad, to 17 feet at the W. B. Buoy, off the eastern edge of the Western Brace and on the western limits of this last-mentioned channel.

262. From Western Sea Reef Buoy to Sola Buoy (71), N. by W. ½ W., distance 28½ miles. From 5 fathoms at the W. S. R. Buoy, shoals gradually on the Western Sea Reef (336) as the line runs up the whole length of it (9 miles), to 1¼ fathoms at half the distance on its head; it then gradually deepens to 3¼ fathoms in the channel [the *old* Swatchway Kell or Kill running up N.N.E. between the head of the Western Sea Reef and eastern edge of the tail of the Eastern Brace (335)]; shoaling to 3 fathoms on the eastern edge of this last named sand at three-fifths the distance; then gradually shoals, as it runs up and across it, to zero, on a patch 1½ miles long, at 1½ miles from the Sola Buoy; after crossing which it deepens to 3 fathoms at this buoy, on the N.W. edge of the Eastern Brace and on the eastern limits of the tapering channel (here from 3 fathoms to 3 fathoms, barely 1 mile broad) running up between the Eastern and Western Braces (335 and 331).

263. From Western Sea Reef Buoy to Western Channel Lower Middle Ground Buoy (219), N. 5° 15′ E., distance 16,200 yards. From 5 fathoms at the W. S. R. Buoy, deepens to 6¼ fathoms at one-third the distance; then shoals as the line runs up along the western side of the South Channel (344) to 4¾ fathoms at the (W. C.) L. M. G. Buoy, off the south-eastern edge of the tail of the Western Channel Middle Ground (217), and on the western limits of the junction of the Western (343) with the South Channel, and 3½ miles to the eastward of 5 fathoms on the eastern edge of the Western Sea Reef (336), and also 4¼ miles to the westward of the western edge of the Eastern Sea Reef (342); thus making the whole width of the South Channel below this buoy 7¾ miles.

264. From Western Sea Reef Buoy to South Channel Reef Buoy (228), N. 45° 15′ E., distance 15,300 yards.

From 5 fathoms at the W. S. R. Buoy, gradually deepens to $7\frac{1}{4}$ fathoms at three-fourths the distance; then shoals to 6 fathoms at the S. C. R. Buoy, half a mile off the steep western edge of the Eastern Sea Reef (342), and on the eastern limits of the South Channel (344): as the line runs up and across this channel.

265. From Western Sea Reef Buoy to Upper Reef Buoy (247), N. 73° 00′ E., distance 20,900 yards. From 5 fathoms at the W. S. R. Buoy, gradually deepens as the line runs across the course of the South Channel (344) to 7 fathoms at half way between the two buoys, and to $7\frac{1}{2}$ fathoms at three-fifths the distance, or three-fourths the distance across the South Channel, and south of the S. C. R. Buoy (228); it then shoals to 5 fathoms on the steep western edge of the Eastern Sea Reef (342), at $7\frac{7}{8}$ miles from the W. S. R. Buoy, which gives the width of the South Channel at this section, and about $2\frac{2}{5}$ miles from the U. R. Buoy (the breadth of Reef): it then shoals rapidly on the western edge of the abovementioned Reef to 21 feet 6 inches (the least water) at one-fourth the distance across it; gradually deepening over the remainder of it to 25 feet at the U. R. Buoy, off its eastern edge and on the western limits of the Eastern Channel (356).

266. **The Lower Reef Buoy.** First class, wood; painted red, marked L. R. in white, and surmounted by a double open red basket beacon, the one basket above the other. Is moored in 33 feet off the south-east edge of the tail of the Eastern Sea Reef (342), and on the western limits of the Eastern Channel (356): this, the outermost buoy, marking the eastern edge of the Reef and western side of this channel, is in Lat. 21° 6′ 25″ N., Long 88° 7′ 35″ E.*

267. From Lower Eastern Sea Reef Buoy* to 5 fathoms on the tail of Western Sea Reef (336), W. $\frac{1}{4}$ N., distance

* This buoy is now (1881) in Lat. 21° 4′ 25″ N., Long. 88° 8′ 35″ E., or $2\frac{1}{4}$ miles S. E. $\frac{3}{4}$ S. of its position as above given.

15 miles. From $5\frac{1}{2}$ fathoms at the L. R. Buoy, gradually shoals to 29 feet on the western side of the tail of the Eastern Sea Reef (41); then deepens rapidly off its steep western edge to 7 fathoms, at one-third the distance, then to $8\frac{1}{4}$ fathoms at half the distance, in the South Channel (344); shoaling gradually as the line runs across this channel (here, from 5 fathoms to 5 fathoms, $8\frac{1}{2}$ miles broad) to 5 fathoms on the tail of the Western Sea Reef. As there is always a swell of some height on the tails of these Sands, vessels must make a large allowance when there is much sea running, and keep to the southward at low water springs, when there is nearly 2 fathoms less water than at high water springs. Vessels have struck the ground in 29 feet at a draught of 21 feet, that is, in 9 feet more than their draught, on some of them.

268. From Lower Eastern Sea Reef Buoy* to Western Sea Reef Buoy (336), W. $\frac{7}{8}$ N., distance $13\frac{3}{4}$ miles. This line crosses much in the same manner as the last, but being a little further north, it carries but 28 feet across the western side of the Eastern Sea Reef (342), and deepens to $7\frac{1}{2}$ fathoms only, on the eastern side of the South Channel (344), after leaving the steep western edge of the Eastern Sea Reef.

269. From Lower Eastern Sea Reef Buoy* to Upper Eastern Sea Reef Buoy (247), N. 37° 30′ W., distance 12,880 yards. From $5\frac{1}{2}$ fathoms at the L. R. Buoy, gradually shoals as the line runs up along, and closes on the eastern edge of the Eastern Sea Reef (342), to 25 feet at the U. R. Buoy, off the eastern edge of the Eastern Sea Reef and on the western limits of the Eastern Channel (356). This line is the western limiting line for this channel, but, as the L. R. is of necessity further out into the channel than is the U. R. Buoy, this line does not run up parallel to the edge of this Reef, but angles in toward it, say half a point.

270. From Lower Eastern Sea Reef Buoy* to Intermediate Light Vessel (238), N. 18° 00′ E., distance 18,000 yards. From 33 feet at the L. R. Buoy, gradually deepens

* See foot-note, page 77.

to 39 feet at half the distance, to 42 feet at three-fourths the distance; and to 43½ feet at the Intermediate Light Vessel, 4,000 yards to the westward of 3 fathoms on the western edge of Saugor Sand (355), and on the eastern side of Mid-Eastern Channel (356): as the line runs up diagonally across this channel.

271. From Lower Eastern Sea Reef Buoy* to Intermediate Light Station Buoy (244), N. 27° 00′ E., distance 16,850 yards. This line is nearly the same as the last given, excepting that it ends in 45 feet at the I. Buoy, instead of in 43½ feet as at the Intermediate Light Vessel, on account of its running more to the southward; and also on account of its terminating much nearer to the steep western edge of Saugor Sand (355) (the line of deepest water).

272. From Lower Eastern Sea Reef Buoy* to Lower Saugor Sand Buoy (254), N. 68° 00′ E., distance 7 miles. From 33 feet at the L. R. Buoy, gradually deepens to 53½ feet at three-fourths the distance; and then shoals to 46 feet at the L. S. S. Buoy, 1⅝ miles to the westward of 30 feet on the steep western edge of Saugor Sand, and on the eastern limits of the Eastern Channel (356). This line runs right across the channel.

273. From Lower Eastern Sea Reef Buoy* to 29 feet on the tail of the eastern prong of Saugor Sand (355), E. ¾ N., distance 23,333 yards. From 33 feet at the L. R. Buoy, gradually deepens to 55 feet at two-fifths the distance; and then gradually shoals to 29 feet (the least water on its tail) on the western side of the eastern prong of Saugor Sand. This line, like the last, measures the breadth of the Eastern Channel (356).

274. From Lower Eastern Sea Reef Buoy* to Mutlah Light Vessel (276), E., distance 35¼ miles. From 33 feet at the L. R. Buoy, deepens gradually to 58 feet half way across the Eastern Channel (356), and when the E. C. Light bears S.W.; then it gradually shoals across the entrance to the Eastern Channel to 30 feet on the eastern

* See foot-note, page 77.

prong of Saugor Sand (355) at three-eighths the whole distance, or about 14 miles from the L. R. Buoy; it then deepens to 7½ fathoms as it crosses the entrance to Lacam's Channel; shoals to 7 fathoms as it passes the steep tail-end of the Subtermooky or Lighthouse Sand, at three-fourths the distance (close to the northward of which spot there is only 5 and 4¾ fathoms); it then deepens gradually to 14 fathoms at the Mutlah Light Vessel, moored off the entrance to the Mutlah River.

275. **The Mutlah Light Station Buoy.** Second class, wood, painted red and white in vertical sections, marked with an anchor in black, and surmounted by a red basket beacon. Lies in 10 fathoms, in Lat. 21° 5′ 30″ N., Long. 88° 46′ 30″ E., 1½ miles N. 5° E. of the Mutlah River Light Vessel, and off the Western Channel of the Mutlah River. Marks the Light Station in the event of the vessel being driven off it.

276. **The Mutlah River Light Vessel.*** A three-masted vessel of about 230 tons, hull painted red with MUTLAH on her sides, yard on foremast, which, with the three mastheads, are painted white; when in position burns a fixed bright light at the main or lantern masthead, 48 feet high by night, also the usual anchor or position light at the forestay as prescribed in the Admiralty Regulations; and throws up a rocket at 8 P.M., midnight, and 4 A.M.† When driven from her position, the usual red light at each end and red quarter-of-an-hour flare-up are shown in lieu of the other lights. Has at her main or lantern masthead by day a red ball beacon surrounded by a white horizontal band, which beacon is struck in the

* Since the above was written, we have the following information concerning this Light Vessel from S. Reed, River Surveyor, dated 28th March, 1881:—"The Mutlah Light is moored in 70 feet mud, Lat. 21° 4′ N., Long 88° 46′ E., and the following is a bearing and distance from it, Mutlah Light Station Buoy, N. 5° E., 1½ miles.

† These rockets are very effectual: for, bursting with a brilliant display of stars at a great height, they have frequently been seen from the E. C. Light Vessel 31½ miles distant.

event of the vessel being driven from her proper position. Is moored in 13½ fathoms off the mouth of the disused Western Channel of the Mutlah River, for which it was originally laid as a leading light, and is now retained as a directing guide to the approaches to the Hooghly. Is in Lat. 21° 4′ N., Long. 88° 46′ 30″ E., and 20 miles west of the edge of the Swatch of No Ground.

277. From Mutlah Light Vessel to 5 fathoms on the tail of the eastern prong of Saugor Sand, west 20½ miles. From 13½ fathoms at the Mutlah Light Vessel, gradually shoals to 7 fathoms at half the distance, off the tail of the Subtermooky or Lighthouse Sand; deepens again to 8¾ fathoms in Lacam's Channel; and then gradually shoals to 5 fathoms on the tail of the eastern prong of Saugor Sand. This line extended passes half a mile south of the Lower Reef Buoy.

278. From Mutlah Light Vessel to 5 fathoms on the tail of the Subtermooky or Lighthouse Sand, N. by W., distance 10½ miles. From 13½ fathoms at the Mutlah Light Vessel, shoals gradually to 5 fathoms on the tail of the Subtermooky or Lighthouse Sand.

279. From Mutlah Light Vessel to 5 fathoms on the tail of Bulcherry Sand, N. W. ¼ W., distance 7 miles. From 13½ fathoms at the Mutlah Light Vessel, shoals gradually to 5 fathoms as the line runs across to the tail of Bulcherry Sand.

280. From Mutlah Light Vessel to 5 fathoms on the tail of Roy Mutlah Sand, N. ½ E., distance 8 miles. From 13½ fathoms at the Mutlah Light Vessel, shoals to 9 fathoms at one-third the distance, and then gradually to 5 fathoms on the tail of the Roy Mutlah Sand.

281. From Mutlah Light Vessel to 5 fathoms on the tail of Bangadoony Sand, N. E. ½ E., distance 20 miles. From 13½ fathoms at the Mutlah Light Vessel, shoals to 10 fathoms at 2 miles distance, to 9 fathoms at one-fourth the distance, and to 8 fathoms half way, or, off the Eastern Channel (Mutlah River): continuing in 8 fathoms until

within 4 miles of the end of the line; then quickly shoals to 5 fathoms on the tail of the Bangadoony Sand.

282. From Mutlah Light Vessel to the northwest angle of the Swatch of No Ground (360), where the soundings suddenly dip from 30 to 153 fathoms, in a run of barely 2 miles on a N.E. by E. course. N. 70° 00′ E., distance 27½ miles. From 13½ fathoms at the Mutlah Light Vessel, deepens gradually to 20 fathoms at four-fifths the distance, then quickly to 30 fathoms when within 2 miles of the end of this line; and then suddenly deepening to 153 fathoms in the N.W. angle of the Swatch of No Ground.

283. **The Eastern Channel Light Station Buoy.** Second class, wood, painted black and white in vertical sections, marked with an anchor and surmounted with an egg-shaped red open basket beacon. Moored in 52 feet in Mid-Eastern Channel (356): marks the Eastern Channel Light Station (286) in the event of the vessel driving from her position. This buoy always out-riding the heavy cyclones (on account of the comparatively smooth water it is moored in), proves very useful after a gale in determining the proper position that the returning pilot vessel should take up, as a substitute for the missing Light Vessel, or for enabling pilots of vessels to find their way in to Saugor from this, the fairway buoy of the Eastern Channel.

284. From Eastern Channel Light Station Buoy to Lower Reef Buoy* (366), N. 45° 45′ W., distance 14,480 yards (7 miles).† From 52 feet at the E. C. Light Station Buoy, gradually shoals to 33 feet at the L. R. Buoy, on the western limits of the Eastern Channel (356) and off the eastern edge of the tail of the Eastern Sea Reef (342); as the line runs diagonally across and up the Eastern Channel.

285. From Eastern Channel Light Station Buoy to 5 fathoms on the tail (of the eastern prong) of Saugor Sand (355), E. by N., distance 12 miles. From 52 feet at the E.

* See foot-note, p. 77. † (4¾ now.)

C. Station Buoy, deepens gradually to 61 feet at 1¼ miles; and after that gradually shoals as the line runs across the Eastern Channel (356), to 5 fathoms on the tail of Saugor Sand.

286. **The Eastern Channel Light Vessel.** Like all the other light vessels, this one is about 230 tons, three masted, and with a yard on foremast only, which, with the three mastheads, is painted white. Hull painted yellowish clay colour, and marked on sides black on a white canvas ground EASTERN CHANNEL. To denote that she is in her proper position, by day—she has a black ball beacon at her main or lantern masthead, which ball is struck should she drive far from her station, and by night—she shows a fixed bright light at her main masthead 48 feet above sea level; the regulation light at her forestay; and, from the 15th of March to the 15th of September, both days inclusive, or when the Ridge Light (342) is in position, she burns a blue light every consecutive half hour, and for the remainder of the year, she burns a blue light every hour only (at the hour intervals) in contradistinction to the Lower Gasper Light's (166) times for burning her blue lights, which (excepting when the Intermediate Light (238) is away from her station) is every hour at the half hours only. No maroons are burnt as formerly, the lights being so powerful that their effect is eclipsed at a distance of a mile or two. Should she drift out of her proper position, her masthead, forestay, and blue lights are not exhibited, but the regulation signal of being out of position shown instead, namely, a red light at each end and a red flare-up every quarter of an hour.

This Vessel* is moored in 10 fathoms in Mid-Eastern

*** Since the above was written, the following information has been issued by S. Reed, River Surveyor, under date 28th March, 1881:—Eastern Channel Light moored in 60 feet mud, Lat. 21° 0′ 45″ N., Long. 88° 12′ E.; and the following are the bearings and distances from it: Eastern Channel Light Station Buoy (283), North, 1 mile, and Lower Reef Buoy (266), N. 47° W., 5 miles.**

Channel, and is a leading light for it, and also serves as a mark for the pilot vessels, whose station, all the year round, is now always in the vicinity of her—in blowing weather to the southward, and in the N. E. monsoon to the W. N. W.; she is in Lat. 21° 1′ 19″ N., Long. 88° 13′ 00″ E.

287. From Eastern Channel Light to Balasore Anchoring Buoy (224), W. by N. $\frac{5}{8}$ N., distance 65$\frac{1}{2}$ miles. From 10 fathoms at the E. C. Light Vessel, shoals to 39 feet at about 3 miles, or when the L. R. Buoy bears N. $\frac{1}{2}$ W.; crosses the tail of the Eastern Sea Reef (342) in 6 fathoms, and deepens to 8$\frac{3}{4}$ fathoms on the eastern side of the South Channel (344), shoals again to 6 fathoms on the tail of the Western Sea Reef (336), with W. R. Buoy bearing N., about 4 miles, and at 18 miles from the E. C. Light; deepens suddenly off the western edge of the tail of this reef from 6 into 10 fathoms in a run of only 1 mile, at one-third the whole distance, as the line crosses just to the northward of the spot marked on the old charts, the Swatch or Kell (338), in the channel formerly called the Swatchway, Kill or Kell; shoals to 6$\frac{1}{2}$ fathoms on the tail of the Western Brace (331) at half the distance; deepens off its western edge to 9$\frac{1}{4}$ fathoms; shoals gradually, passing through 7$\frac{1}{2}$ fathoms, mud with shells and sea-eggs, 20 miles from the Balasore Anchoring Buoy, and goes on gradually shoaling to 2$\frac{3}{4}$ fathoms at this buoy, 4 miles off the low coast of Balasore, and mouth of the river of that name, and in the N.W. part of Balasore Roadstead (332), in Lat. 21° 24′ 15″ N., Long. 87° 06′ 00″ E.

288. From Eastern Channel Light Vessel to 5 fathoms on the tail of the Western Brace (331), W. N. W., distance 35 miles. From 10 fathoms at the E. C. Light Vessel, shoals to 38 feet at about 3 miles distance, or when the L. R. Buoy bears N. $\frac{1}{2}$ W.; crosses the tail of the Eastern Sea Reef (312) in 33 feet at one-fifth the distance; deepens to 8$\frac{1}{2}$ fathoms on the eastern side of the South Channel (344); crosses the tail of the Western Sea Reef (336) in 4$\frac{1}{4}$ fathoms at three-fifths the distance; deepens to 9$\frac{1}{4}$ fathoms

on the eastern side of the Swatchway Kill or Kell (338) at four-fifths the distance; then shoals gradually across it to 5 fathoms on the tail of the Western Brace (331), in Lat. 27° 14′ 30″ N., Long. 87° 40′ E. This line passes three-quarters of a mile south of W. S. R. Buoy (259).

289. From Eastern Channel Light Vessel to Lower Reef Buoy (266)* N. 40 W., distance 15,310 yards, or 7½† miles. From 10 fathoms at the E. C. Light Vessel, shoals to 40 feet at half the distance, and to 33 feet at the L. R. Buoy, off the eastern edge of the tail of the Eastern Sea Reef (342), and on the western limits of the Eastern Channel (356), and in Lat. 21° 6′ 25″ N., Long. 88° 7′ 30″ E.

290. From Eastern Channel Light Vessel to Lower Gasper Light Vessel (166), N. by W. ¼ W., distance 25¾ miles. From 10 fathoms at the E. C. Light Vessel, passes to the westward of the E. C. Light Station Buoy (283) in 51 feet; then shoals gradually to 35 feet 1¾ miles W. by S. of the Intermediate Light Vessel (238) at about five-eighths the distance; then shoals to 30 feet three-fourths of a mile east of the Bell Buoy (204), to 29 feet half a mile east of L. M. G. Buoy (194), and to 27 feet at the Lower Gasper Light Vessel (166), at the head of the Eastern Channel (356) and junction of it with the Gasper Channel (351). This last line is the channel course between the two light vessels; but, with a heavy sea running a course should be shaped to avoid the shoal tail of the Middle Ground (352), in the vicinity of the Bell Buoy.

291. From Eastern Channel Light Vessel to Intermediate Light Vessel (238), N. 7° 00′ W., distance 13½ miles. From 10 fathoms at the E. C. Light Vessel, passes close to the westward of the E. C. Light Station Buoy (285) in 52 feet; shoals to 44 feet at one-third the distance; deepens to 48 feet at half way; then shoals gradually to 43½ feet at the Intermediate Light Vessel, on the eastern side of Mid-Eastern Channel (356) and 4,000 yards off the western edge (at 23 feet) of Saugor Sand (355).

* See foot-note, p. 77. † Only 5 now.

292. From Eastern Channel Light to Lower Saugor Sand Buoy (254), N. by E. ¼ E., distance 8½ miles. From 10 fathoms at the E. C. Light Vessel, shoals to 52 feet as it passes close to the eastward of the E. C. Station Buoy (285); deepens to 55 feet at less than one-fourth the distance; shoals to 54 feet at two-thirds the distance, and to 46 feet at the L. S. S. Buoy, 1½ miles off the 30 feet line of soundings on the western edge of Saugor Sand (355), and on the eastern limits of the Eastern Channel (356). This buoy being in Lat. 21° 9′ 00″ N., Long. 88° 14′ 30″ E.

293. From Eastern Channel Light Vessel to 5 fathoms on the tail of the eastern prong of Saugor Sand (355). N. E. by E. ¾ E., 9 miles. From 10 fathoms at the E. C. Light Vessel, deepens to 62 feet at 1 mile distance; shoals again to 61 feet at one-fourth the distance; and then gradually shoals across the entrance to the Eastern Channel (356) to 30 feet on the edge of the tail of the eastern prong of Saugor Sand; carrying this depth right across the Sand, on this line for a distance of 2 miles. In Lat. 21° 4′ N., Long. 88° 23′ 45″ E.

294. From Eastern Channel Light Vassel to 5 fathoms on the tail end of Subtermooky or Lighthouse Sand, E. by N. ½ N., distance 11 miles. From 10 fathoms at the E. C. Light Vessel, gradually shoals to 5½ fathoms on the tail of Saugor Sand (355) (eastern prong) at half way; deepens again to 8 fathoms, at the mouth of Lacam's Channel, at three-fourths the distance; then gradually shoals to 5 fathoms on the tail end of the Subtermooky Sand, on the eastern side of Lacam's Channel, and in Lat. 21° 6′ 30″ N., Long. 88° 35 E. This line carried 6½ miles further, crosses the tail of Bulcherry Sand in 6 fathoms.

295. From Eastern Channel Light Vessel to Mutlah River Light Vessel, E. ¾ N., 31½ miles. From 10 fathoms at the E. C. Light Vessel, gradually shoals to 8 fathoms off the tail of Saugor Sand (355) at one-third the distance; deepens again to 9½ fathoms at half way, off the mouth of Lacam's Channel; deepens to 10 fathoms at two-thirds the

distance, and then to $13\frac{1}{2}$ fathoms at the Mutlah Light Vessel, off the disused channel leading to the River Mutlah.

296. **The South Channel Buoy.** First class, iron, painted black with a white oval space, in which are the letters S. C. in black, and is surmounted with a black open basket beacon. Is moored in 11 fathoms, in mid channel off the entrance of the South Channel (344), and in Lat. 21° 00′ 00″ N., Long. 87° 58′ 30″ E.

297. From South Channel Buoy to Balasore Buoy (224), N. W. by W. $\frac{7}{8}$ W., distance $54\frac{1}{2}$ miles. From 11 fathoms at the S. C. Buoy, shoals gradually to 7 fathoms on the extended tail of the Western Sea Reef (336); and deepens quickly to 10 fathoms at $7\frac{3}{4}$ miles, and then to $12\frac{1}{2}$ fathoms in the Swatch Kell or Kill; shoals again to 9 fathoms, at one-fourth the distance; and runs along in that depth, or, varying from 9 to 10 fathoms to two thirds the distance; then shoals gradually to 3 fathoms at the Balasore Anchoring Buoy, 4 miles off the low lying coast of Balasore.

298. From South Channel Buoy to 5 fathoms on the tail end of Western Brace (331), N. W. $\frac{3}{4}$ W., $24\frac{1}{2}$ miles. From 11 fathoms at the S. C. Buoy, gradually shoals to 6 fathoms on the tail of the Western Sea Reef (336) at one-fourth the distance; deepens suddenly from 7 to 10 fathoms in the Swatchway Kill or Kell (338) at two-fifths the distance, shoals to 9 fathoms at three-fifths the distance, and gradually to 5 fathoms at the tail end of the Western Brace, in Lat. 21° 15′ 45″ N., Long. 87° 38′ 30″ E.

299. From South Channel Buoy to 5 fathoms on the tail end of Western Sea Reef (336), N. W. $\frac{1}{2}$ N., distance $9\frac{1}{4}$ miles. From 11 fathoms at the S. C. Buoy, shoals gradually to 5 fathoms on the tail end of the Western Sea Reef.

300. From South Channel Buoy to Western Sea Reef Buoy (336), N. 30° 15′ W., distance 21,500 yards. This line runs nearly the same as the last, only that it shoals to 5 fathoms at the W. S. R. Buoy, off the eastern edge of

the tail of the Western Sea Reef (336) and on the western limits of the South Channel (344).

301. From South Channel Buoy to South Channel Reef Buoy (296), N. 3° 30′ E., distance 14¾ miles. From 11 fathoms at the S. C. Buoy, shoals gradually to 6 fathoms at the S. C. R. Buoy, as the line runs up the South Channel (344) to the latter buoy, on its eastern limits, and off the western edge of the Eastern Sea Reef (342).

302. From South Channel Buoy to Upper Reef Buoy (247), N. 20° 15′ E., distance 26,380 yards. From 11 fathoms at the S. C. Buoy, gradually shoals to 30 feet on the western edge of the Eastern Sea Reef (342), at three-fifths the distance, and to 24 feet on the Reef at four-fifths the distance; and carries not less than this as the line runs up and across the Reef; then deepens to 25 feet at the U. R. Buoy, off the eastern edge of the Eastern Sea Reef and on the western limits of the Eastern Channel (356).

303. From South Channel Buoy to Lower Reef Buoy* (266), N. E. ½ E. nearly, distance 10 miles. From 11 fathoms at the S. C. Buoy, shoals gradually to 32 feet on the tail of the Eastern Sea Reef (342) at four-fifths the distance; deepening to 33 feet at the L. R. Buoy, off the eastern edge of the tail of this Reef, and on the western limits of the Eastern Channel (356).

304. From South Channel Buoy to Eastern Channel Light Vessel (286), E. ½ N., distance 12⅝ miles. From 11 fathoms at the S. C. Buoy, gradually shoals to 8 fathoms off the tail end of the Eastern Sea Reef (342), when the L. R. Buoy bears N.N.W.; and then deepens off it quickly to 10 fathoms at the E. C. Light Vessel at the entrance or mouth of the Eastern Channel (356).

305. **The Pilot's Ridge Light Station Buoy.** A first class wooden buoy, painted white, with black oval space, in which are the letters P. R. in white, and surmounted with a red basket beacon. Moored in 22 fathoms

* See foot-note, p. 77, and apply it.

on the northern end of Pilot's Ridge (328), and marks the Light Station of that name. The soundings about it are sand with red specks and shells, with here and there small pieces of broken tubes (of the size, and like halves and parts of semi-transparent goose-quilltubes) of boring marine insects, which are brought out of the Kunka River. Some of the small shells are about one-eighth to one-fourth of an inch in diameter, and resemble flat cockle shells in their construction. Others are small spirally constructed tapering shells. High water at this buoy at 8h. 30m. full and change, with a rise of 8 or 9 feet. The flood-tide sets about N. W. to north, and the ebb about S.E. The sea in the S.W. Monsoon is usually smoother here on the Ridge than off it, owing to its being sheltered by False Point. For Lat. and Long., see Pilot's Ridge Light (212).

306. From Pilot's Ridge Buoy to Kannaka Buoy (313), W. ¼ S., distance 38¼ miles. From 22 fathoms sand, red specks, and shells at P. R. Buoy, shoals to 20 fathoms sand, mud, and shells at 5 miles; to 18 fathoms, mud, sand, black and white specks; at 12½ miles; to 17 fathoms coarse sand, yellow and black specks and shells, at half the distance; to 15 fathoms 2½ miles north of Palmyras Reef Buoy (319), which is in yellow clay, and 3½ miles to the southward of 13 fathoms, where there is mud, sand, black specks, stones, and shells, at 26 miles distance; strikes the 10-fathom line at 4 miles distance from Kannaka Buoy, gradually shoaling to 4½ fathoms at the K. *Anchoring* Buoy on the eastern edge of the mud flat off the shore.

307. From Pilot's Ridge Buoy to Balasore Buoy (224), N. W., 46¼ miles. From 22 fathoms, sand, red specks, and shells at the P. R. Buoy, as the last, shoals to 20 fathoms, sand, mud, and shells at 5 miles; to 17 fathoms, grey sand, small pebbles, and broken shells at 11½ miles, one-fourth the distance; to 13 fathoms stiff mud or clay, pebbles and broken shells, at 19 miles distance; to 12 fathoms, half way (which is a central position between

the Kannaka Buoy (313) to the S.W., the Balasore Buoy to the N.W., 3 fathoms on the tail of Western Brace (331) to the N. E., and the Pilot's Ridge Buoy (305) to the S.E.), to 10 fathoms; olive mud, broken shells and pebbles, at five-eighths the distance; to 7 fathoms, dark sand and mud, at 34 miles or three-fourths the distance; then gradually to 3 fathoms at the B. Anchoring Buoy, off the eastern edge of the flats off Balasore Beach, and over 4 miles from dry land near Chandipore, and which lies on this line nearly.

308. From Pilot's Ridge Buoy to 5 fathoms on the tail of Western Brace (331), N. ¾ W., distance 25½ miles. From 22 fathoms, sand, red specks, and shells, at Pilot's Ridge Buoy (305), shoals to 20 fathoms, sand, mud, black and white specks, broken shells, at 6½ miles, or one-fourth the distance; to 19 fathoms, dark sand, mud, pebbles, and small shells at 9 miles distance; to 12 fathoms, mud, at three-fifths the distance, and then gradually to 5 fathoms on the tail of Western Brace.

309. From Pilot's Ridge Buoy to 5 fathoms on the tail of Western Sea Reef (336), N. E. by N. ½ N., distance 21 miles. From 22 fathoms, sand, red specks, and shells, at P. R. Buoy, shoals to 21 fathoms at one-fourth the distance, coarse sand with shells, and to 20 fathoms, dark mud at half the distance, to 10 fathoms at three-fourths the distance, then to 5 fathoms on the tail of the Western Sea Reef; and continuing this line for another 2½ miles, and after shoaling to 4¾ fathoms, the Western Sea Reef Buoy (259) is reached: which buoy is laid on the eastern edge of this Reef as a western buoy of the South Channel (344).

310. From Pilot's Ridge Buoy to 5 fathoms on the tail of Eastern Sea Reef (342), N.E. by E., 28 miles.

It may be here stated that this N.E. by E. rhomb has been found in my experience to be the course of greatest right deviation in most iron vessels just from England: providing the correcting magnets, and other adjustments

were in the same position as they were when the vessels' compasses were adjusted by them there: such is the effect of the altered horizontal force on compass and magnets (see also 168).

Distance 26½ miles. From 22 fathoms sand, red specks, and shells at the P. R. Buoy, deepens to 24 fathoms, dark mud and sand with reddish specks, at one-third the distance; then gradually shoals to 12 fathoms, olive mud, at the South Channel Buoy (296), at 19½ miles, or over two-thirds the distance, then to 5 fathoms on the tail of Eastern Sea Reef (342), 3 miles from the Lower Reef Buoy (266), nearly on this line (but *see* foot-note, page 77).

311. From Pilot's Ridge Buoy to Eastern Channel Light Vessel (286), E.N.E., distance 32 miles. From 22 fathoms, sand, red specks, and shells, at P. R. Buoy, deepens to 23 fathoms, sand, reddish specks, at one-fourth the distance, and to 24½ fathoms (just to the northward of a patch of sand and shells, amber specks, pebbles, and coral) at 11½ miles distance; then in mud and sand; gradually shoals across in olive mud to 10 fathoms at the Eastern Channel Light: in the near vicinity of which, in the N.E. Monsoon, and in the S.W. Monsoon 6 to 8 miles to the S.S.W. is the Station for Pilots (361).

312. **The Pilot's Ridge Light Vessel*** is rigged, like all the other Hooghly light vessels, with three masts, with a yard on the foremast only, which with the mast-heads is painted white; shows by night one fixed dioptric light at the mainmast head, 48 feet above the water line, and the regulation forestay, anchor or position light, when in her proper position; and when driven off her station or out of position, shows the authorized signal, namely, a

* Since the above was written, the following information has been issued by S. Reed, River Surveyor, dated 28th March, 1887:—Pilot's Ridge Light, moored in 129 feet water, sand, black and white specks, with broken shells, in Lat. 20° 49′ 15″ N., Long. 87° 39′ 15″ E., and the bearings from it are: Pilot's Ridge Station Buoy (305), N. 45° E., 1½ miles.

red light at each end and a red flare-up every quarter of an hour. By day her signal of being in position is a white ball with a black horizontal band round its centre, at the main or lantern masthead, which is struck in the event of the vessel driving off her station, Her hull is painted like the other lights of the Hooghly, a yellowish clay colour, and has her name PILOT'S RIDGE on her side, black on white ground: and in addition to her dioptric light, burns a blue light every hour at the hour intervals. None of the light vessels burn the old maroons or flare-ups, now that the lights are so good they are of little use. This light is moored in 22½ fathoms water: in Lat. 20° 50′ 20″ N., Long. 87° 40′ E. The nature of the soundings will be found as per Pilot's Ridge Station Buoy (last given). The sheen of the blue lights is often seen, in the low clouds of the S.W. Monsoon current, at a distance of over 30 miles. Formerly the Pilot Station was near this Light Vessel, as is still set forth in most Sailing Directories; and on that account, the commander of this vessel is always ready to direct shipmasters by signal how to steer to find the Pilot Brigs (E.N.E., 32 miles).

This Light Vessel is removed from the station on the 15th of September, or at the end of the S.W. Monsoon, and is replaced in position on the 15th of March of each year; during which interval the Eastern Channel Light Vessel burns a blue light at the hour intervals only, and not at every succeeding half hour, as she does when this Light Vessel is in position. For tide* bearings, &c., see Pilot's Ridge Station Buoy (305), which buoy lies 1½ or 2 miles N.N.W. of this Light Vessel.†

313. **The Kannaka Buoy.** A first class wooden buoy, painted black (as an eastern buoy), and marked with a K. and anchor in white, and is surmounted with

* For set of Sea Current, see 379.

† *See* foot-note of preceding page.

a black basket beacon and bell: is laid in 4 fathoms on the eastern edge of the extensive flat at the entrance to the Kannaka or Kunka, or as now called the Dumrah River (333), and marks the eastern limits of the channel leading to that river, and western limits of Kannaka Roads. (Shorts' beacon on the southern side of the south entrance, erected on the flat, bears from this buoy S.S.W. 5,450 yards.) High water full and change days at 8h. 25m. and rise of tide on springs 10 to 12 feet; neaps 7 to 8 feet. [*See* "Chandbally to sea" (333).]

314. From Kannaka Buoy to the nearest dry land West, 6½ miles. From 4 fathoms at K. *Anchoring* Buoy, shoals quickly to 3, 2, and 1 fathom, and then on to the extensive Flat, which is dry at low water, at one-third the distance; then across this flat to dry land.

315. From Kannaka Buoy to mouth of Churrimoon Creek N. W. by N., distance 25½ miles. From 4 fathoms at the K. *Anchoring* Buoy, carries that water for half the distance as the line runs up Kannaka Bay almost parallel to the adjacent edge of the extensive flat; it then, abreast Biddypore, shoals gradually on low-water mark flats as it approaches the shore at the mouth of the creek. The soundings are greenish mud, until shoaling on the flat at half the distance and abreast of Biddypore.

316. From Kannaka Buoy to mouth of Balasore (29) or Bulramgurry River, N. ¼ W., distance 37½ miles. From 4 fathoms at K. *Anchoring* Buoy, deepens gradually to 9 fathoms at 4½ miles distance as the line strikes out and up across the western segment of Balasore Roads (332); shoaling to 8 at one-fourth the distance, in the greenish mud and probably sand and shells, to 7 fathoms at two-fifths the distance, in mud, specks, and shells; then gradually shoals onwards as the extensive flat off the coast is reached.

317. From Kannaka Buoy to Beercool Bungalow, N.E. by N. ¾ N., distance 53 miles. From 4 fathoms at K. *Anchoring* Buoy, deepens quickly to 6 fathoms, and to 10 fathoms at 3½ miles; to 12 fathoms, mud, sand black specks,

stones, and shells at 5½ miles; then gradually shoals up across the centre of Balasore Roads (332) to 7 fathoms, at a remarkable patch of mud with shells and *sea-eggs*, at 33 miles distance; where, the Sugarloaf, the southernmost peak detached from the adjacent Nilghiri Hills, bears west 19 miles; then the line shoals gradually as it runs up to the westward of the Western Brace to the low-water flat, and to the bungalow to the northward of the Quoin Sandhill on the shore.

318. From Kannaka Buoy to 5 fathoms on the tail of Western Brace (331), N. E. ⅜ E., 44¾ miles. From 4 fathoms at K. *Anchoring* Buoy, deepens quickly to 6 fathoms, and to 11 fathoms 4 miles off, to 13 fathoms, mud, sand black specks, stones, and shells at 5½ miles, to 13½ fathoms, grey sand, mud, and shells at 15 miles; and same depth, with stiff mud or clay, pebbles, and broken shells at half the distance; shoals to 10 fathoms when 5½ miles from the tail of Brace; then gradually shoaling to 5 fathoms on the tail of Western Brace. [To 5 fathoms on tail of W. B. N. E. by E. ⅞ E., 47½ miles.]

319. **The Palmyras Reef Buoy.** A second class wooden buoy, painted red and white in horizontal rings or sections, marked P. R., and surmounted with a beacon. Is laid in 13½ fathoms, yellow clay; just off, and marking the N. E. verge of the steep outlying reefs or shoals (329), off, what was, Mypurra Island fronting Palmyras, or the True Point. The buoy is in Lat. 20°47′ 45″ N., Long. 87° 12′ E.

320. From Palmyras Reef Buoy to Kannaka Buoy (313), W. by N. ½ N., distance 7½ miles. From 13½ fathoms at the P. R. Buoy, shoals quickly to 8 as the line skirts the edge of the reef at 1½ miles, then gradually to 6, till within half a mile of the K. *Anchoring* Buoy, then suddenly to 4 at the latter buoy. This line should not be passed by heavy ships working out against an easterly wind.

321. As all the other rhombs will be nearly the same as that from the Kannaka Buoy, I will merely give as follows:

From Palmyras Reef Buoy to Western Sea Reef Buoy (259). N. E. by E. ⅛ E., distance 44 miles. From 13½ fathoms at P. R. Buoy (yellow clay), deepens gradually to 16 fathoms, coarse sand with yellow and black specks and shells, at 8 miles; to 17 fathoms, sand, mud, with black and white specks at one-third or at 15 miles distance; to 18½ fathoms, grey sand, small pebbles; and broken shells at half way; to 19½ fathoms, dark sand, mud, pebbles, and small shells at three-fifths the distance, on the N.W. edge of Pilot's Ridge (328), with the Pilot's Ridge Light Vessel (312) about 10½ miles south; shoals to 16½ fathoms, yellow clay, in the Swatchway or Kell (338), 7 miles from 6 fathoms on the S.W. edge of the tail of Western Sea Reef, and to 10 fathoms 1½ miles from it; then shoals to 4½ fathoms and for another 2¾ miles runs across the tail of Western Sea Reef (336), to the W. S. R. Buoy, lying in 5 fathoms on its eastern edge.

322. From Palmyras Reef Buoy to Pilot's Ridge Station Buoy (305), E. ¾ N., distance 26½ miles. From 13½ fathoms, yellow clay, at the Palmyras Reef Buoy, deepens gradually to 17 fathoms, coarse sand with yellow and black specks and shells, at about one-third the distance, or 7½ miles (the nearest); to 19 fathoms, mud, sand with black and white specks at 13½ miles, or about half way; to 20 fathoms, coarse sand, reddish specks and shells, on the Pilot's Ridge (328), 7½ miles to the W.S.W. of the Pilot's Ridge Buoy, or about three-fourths the distance, but with mud mixed with it on this line, and to the northward of it the red specks predominating; and then to 22 fathoms at the Pilot's Ridge Buoy (for soundings at which see (305).

323. **False Point Lighthouse.** At the entrance to the River Mahanuddy, about 1½ miles west of Mahanuddy Point and 1¼ miles from the sea, in Lat. 20° 20′ 20″ N., Long. 86° 44′ 00″ E. First order dioptric light seen from a ship to bear from S.S.E. round by W. to N. E., or over an arc of 235 degrees, visible 18 to 20 miles, the height of centre

of lantern being 126 feet above highwater mark. From the base of lighthouse to vane 129 feet high; built of reddish granite stone with a large white star painted half way up on its seaward side.

We learn from the latest published Chart of False Point Harbour, No. 1163 of the Marine Survey Department of the Government of India, about Dowdeswell Island, a long crescent-shaped strip or ridge of accumulated sand and broken shells: that, with a radius of $3\frac{1}{2}$ miles, the segment of a circle of $7\frac{1}{4}$ points may be described on the 20-foot line of soundings outside and on its sea-face, or right from its northernmost end, Reddie Point, to its southernmost end, Turtle Point; from a position as its centre S.W. $\frac{1}{2}$ S. of Reddie Point and N.W. by W. $\frac{1}{4}$ W. of Turtle Point: and as said before, $3\frac{1}{2}$ miles distant, and W. by S. $\frac{7}{8}$ S., $2\frac{5}{8}$ miles off Hookey Tollah, the westernmost point of its irregular in-shore line: which gives a run of about $4\frac{3}{4}$ miles for the whole length of the Island, off in this depth of water (20 feet). This 20-foot line of soundings is about seven-tenths of a mile from dry land at Mahanuddy Point, and also after it has crossed this river's mouth (the Mahanuddy) off Turtle Point, and a quarter of a mile outside the breakers in fine weather; but it cuts in close to Reddie Point as it curves in and round the bend of the crescent-shaped outline of the coast, the 30-fathom line also keeping but a short distance from it, from one-quarter to half a mile, say.

Reddie Point, the extreme north end of Dowdeswell Island, bears from Turtle Point, its extreme southern end N. $\frac{1}{2}$ W., distant, as the crow flies, 4 miles. This line, passing the western side of the Island without touching dry land, passes Prince Arthur's Point, close to, at $1\frac{1}{8}$ mile, and the projection of Hookey Tollah at $2\frac{1}{4}$ miles, as it runs over shoal places with 1 and 2 feet only of water here and there, and mud flats.

In continuation of the narrow strip of dry land of Dowdes-

well Island, terminated by Turtle Point and opposite to it, the corresponding spit or neck, as another long ridge (really another Island), runs down in a south-westerly direction for $3\frac{3}{4}$ miles from its north-easternmost end, Buffalo Point, which lies four-tenths of a mile N.N.W. of Turtle Point, and is separated from the latter by a mere mud flat, with but little water upon it. The spit is three-fourths of a mile broad at its widest, northernmost part, one-fourth of a mile, half way down to the Lighthouse, and, like Dowdeswell Island, is covered with small sand hillocks, grass, and scrub.

The north entrance to the River Mahanuddy is situated between the south end of this tongue or spit of land, and a low alluvial island whose sea-line is $1\frac{3}{4}$ mile due east of the Lighthouse, and on which the breakers beat heavily, as they do all along this coast, during S.E. gales.

The 20-foot line of soundings, before described, passes northward at about the same distance, east of the dry land of this island and its north-easternmost end called Mahanuddy Point, as it does off Turtle Point, 2 miles further north-east, or seven-tenths of a mile.

The 40-foot line of soundings running abreast of this Island N.N.E. cuts at a distance of 1 mile from the eastern edge of it or $2\frac{3}{4}$ miles east of False Point Lighthouse; $1\frac{1}{2}$ miles off the Mahanuddy, but only half a mile off, half way between the Lighthouse (when it bears S. W. $\frac{1}{2}$ W.) and Reddie Point, running up here N. $\frac{1}{4}$ E.; but increases to $1\frac{1}{2}$ miles when the pitch of Point Reddie bears west: it then strikes off again in a N.N.E. direction. With False Point Lighthouse bearing west, on the 40-foot line, the east end or side of Dowdeswell Island bears N. $\frac{1}{2}$ E.

Hookey Tollah lies on the centre of the westernmost part of the Island, here four-fifths of a mile broad, and is the station where resides the Government officials, Port Officer, Customs Officer, &c. There is a flag-staff erected near it, and there is a telegraph station some little distance up on the left bank of the Jumboo River, due west of Hookey Tollah, the approach to which is through channels between mud flats marked off by bamboos, &c.

The anchorage is situated, and extends from the Fairway Buoy on the north, in 22 feet, right down to Hookey Tollah: the water shoaling gradually to 7 feet, with a bottom of slushy soft mud, in which a vessel may ground without much danger.

Besides the Fairway Buoy, the harbour or anchorage is marked off by six others, three black and three red, which will be described.*

The line of Plowden Point Beacon (situated on the northern end of a stretch of land running north from the Lighthouse) on with False Point Lighthouse, bearing S. by W. $\frac{3}{4}$ W., cuts close to the dry flat off the N. W. pitch of Reddie Point, and which flat is marked close to this line by a small red buoy: so that the Lighthouse must be kept well to the westward of this beacon when rounding the N.N.W. end of the Point, so as to clear both this small buoy, and the Red Spit Buoy laid further out to the northward.

The Fairway Buoy bears from the Tripod Beacon, which appears to be the most prominent, though the southernmost of the numerous marks to be seen on Reddie Point, N.W. by N. $\frac{1}{2}$ N., a little less than $1\frac{1}{8}$ mile distant, N. by W. $\frac{3}{4}$ W., of the nearest dry land, and is moored in 22 feet. It is painted black and white in vertical sections and marked with an anchor. There is anchorage with 23 feet of water between it and the Point, but less to the westward of this line. Of course there is more water outside, but the rollers, running up along the coast line, make it an objectionable anchorage in the S.W. Monsoon. There is 20 and 21 feet for 2 or 3 miles north of this buoy, with it on with the west side of Reddie Point.

The Red Spit Buoy or A Buoy is laid in 22 feet $4\frac{1}{2}$ cables' length, or $\frac{9}{20}$ mile S. by E. of the Fairway Buoy, at $1\frac{1}{2}$ cables' length from the shore and immediately off the north-western edge of the flat running off a short dis-

* Another large buoy has lately been laid to the N.N.W. of the Fairway Buoy—1881.

tance from Reddie Point: a little distance S. by E. of which, and in a line with the line from the Fairway Buoy, is laid a small red buoy on the inner edge of this flat and marking its dry edge, and which small nun buoy is cut by the old *Fairway* line, of, Plowden Point Beacon on False Point Lighthouse: thus showing how rapidly this spit of sandy drift is growing towards the N. westward. This last was the leading mark 10 years ago.

The B Buoy, the first buoy on the right hand on entering after leaving the Fairway Buoy, is laid in 15 feet, is painted black, and bears from the latter buoy S. by W. ½ W., 5½ cables or $\frac{11}{20}$ mile. From it the extreme pitch of Reddie Point bears E. ½ S., distance 3½ cables, the depth gradually increasing as this line crosses the anchorage towards the Point to 20 feet at from half to three-fourths of a cable from the small red buoy marking the dry edge of the spit, the water shoaling very rapidly at the Point: and which buoy is in this line.

The D Buoy is the next or second black buoy on the right or starboard hand on steaming in; it is in 15 feet, and lies S. ½ E., 5¾ cables from the B Buoy last described, and is just to the westward of the line Plowden Point Beacon on False Point Lighthouse: and, also, this line cuts the pitch of Reddie Point, which bears from this buoy N.W. by N. ½ N. This buoy at present (1880) lies in mid channel, as there is 13-feet a cable to the westward of it. There is 14 feet for a quarter of a mile in to the southward of this buoy.

The F Buoy is the last black buoy marking the right or starboard hand side on entering. It is laid in 10 feet with 13 feet in mid channel, with a cable's length between 10 feet on each side, east and west. It is laid right on the line of Plowden Point Beacon on False Point Lighthouse. The Flag-staff on Hookey Tollah bearing from this buoy S. E. ½ E., 1 mile.

The first red, left, or port hand buoy on entering is the Red Spit Buoy already described.

The C Buoy is the second red buoy (omitting the small buoy marking the steep dry edge of the flat) marking the port or left hand side on entering the harbour. It is laid in 12 feet on the eastern limits of the channel, and is in a line of Red Spit Buoy on small red nun buoy just described, or with those buoys bearing N. ¼ E., and 2 cables' length, or one-fifth of a mile E. by N. ½ N. of the D Buoy; in the channel there is 15 feet as the latter buoy is approached. These two buoys and Tripod Beacon on Reddie Point are all in one line.

The E Buoy is the innermost red buoy marking the eastern limits of the harbour, and is laid in 11 or 12 feet. It also may be said to mark the limits of the narrow gut of anchorage for vessels of small draught, requiring more than 13 or 14 feet of water, which is to be found half a cable's length N.W. of this buoy, and one-sixth of a mile S.S.E. of the F Buoy. The D Buoy lies two-thirds of a mile N.W. by W. ½ W. of Hookey Tollah Flag-staff.

The Iron Beacon with bamboo staff is set up in 1 or 2 feet at low water, two-fifths of a mile W. ½ S. of F Buoy, N. ¾ E., 1⅘ mile of Plowden Point Beacon, and N. W. by W. ½ W., 1$\frac{3}{10}$ mile from Hookey Tollah Flag-staff; this last line cutting the D Buoy. About a quarter of a mile S.S.W. of this is a wreck-buoy; also there is a wreck about 1 mile W.S.W. of Fairway Buoy.

The water to the southward of the E Buoy gradually shoals till it ends in a narrow boat-creek of freshwater from the Mahanuddy, and which runs close up to the Lighthouse. It has 2 or 3 feet of water in it, and is marked off with bamboos.

To the westward of the Iron Tripod or Beacon there is a somewhat shoal channel leading away W.S.W. towards and joining Bacoad Creek; which is buoyed off with small buoys, black and red, as is the anchorage just described. Also there is a boat-channel leading among the extensive mud flats into the Jumboo River, where is situated the canal leading to the Dhumrah and elsewhere; also the Elec-

tric Telegraph station is but a short distance up this river on the starboard hand on entering, or left bank.

But all the expanse lying between Reddie Point on the east, Temple Point to the mouth of the Baroni River on the west, and Plowden Point on the south, is occupied with extensive flats of sand and mud, interspersed with numerous creeks, and boat tracks, marked off with bamboos. The small space contained between the Dowdeswell Island, a long ridge of drifted sand, shingle, and broken shells, doubtless the offering to the sea of the Mahanuddy, rolled up by the force of the ground swell, ever heaving its white-crested waves on to this beach, and the main land to the westward, containing about 12 square miles, seems ultimately doomed to become dry land: as it is fast filling up with the clay and sandy particles brought down by the rivers debouching on it.

One or other of the British India Steam Navigation Company's steamers call here both on their way to and from Calcutta once a week, and there is, by means of Captain Bulloch's steam launches, and otherwise, communication kept up between this Port and Cuttack by the canal routes, and cargo is often obtainable here for small vessels.

It is high water, full and change, at 9h. 15m., and the tide rises 7 feet in the springs, and 4 feet in the neaps at Hookey Tollah. The flood-tide sets north, outside, and to seaward of Dowdeswell Island, follows the crescent-like contour of the shore, round Reddie Point flowing westward, and then, spreading out over the littoral, flows down south through the anchorage and past Hookey Tollah. The ebb sets the reverse way.

And, here, in connection with this very interesting question—the formation and growth of these tongues of Sand—we may reap instruction from "The Rudiments of Physical Geography," by H. F. Blanford, which tells us as follows at page 48:—

"In the Bay of Bengal the currents change with the monsoons. During the S.W. Monsoon, and indeed as

long as S.W. winds blow on the coast of India (which is during nearly eight months of the year), a strong current runs up the coast from south to north; while in the winter months, when the wind is from north-east, the currents run less strongly from north to south. These currents have had an important influence on the shape of the coast, as we shall see when we have to speak of that subject. It is partly owing to them that the east coast line of India is so straight as it is seen to be on the map, and that as a consequence, it is so devoid of good harbours."

We read too at page 127:—

"The shallow swampy lakes that occur in certain river deltas, such as the salt lake to the east of Calcutta, are more properly termed lagoons; and the same term is applied to those sheets of brackish or saltish water that occur on certain parts of the coast, of which the Chilka Lake, in Orissa, and the Pulicat Lake to the north of Madras are good examples. The former of these are portions of the delta lying between the river channels; and which the sediment deposited in them, year by year, has not yet sufficed to fill up to the ordinary dry weather water-level. In some cases, such as the examples cited, they are more or less salt, because they communicate by certain channels with the sea, so that salt-water passes into them at every tide. The Chilka and Pulicat Lakes have been formed in a different way. They are separated from the sea by a ridge of sea-sand, termed a sand-spit, and formed by the sand drifted up the coast by the current above noticed. To take the case of the Chilka, the sand accumulating along the shore of Ganjam and other more southerly parts of the coast, is gradually drifted northwards by this current, being added to by the sediment of every river that discharges itself into the Bay. At some former time, the sea must have washed the base of the hills that lie to the west of the Chilka; but this sea having become shallow by the sediment poured into it by the Mahanuddy and the smaller streams from the interior, a sand bank was formed by the coast current, tailing off from the southern extremity of the lake, until the lagoon behind it was completely enclosed. The sea alone could not raise this higher than the sand could be washed by the breakers; but as a part of it would be laid bare and dried by the sun at every tide, the dry sand would be caught by the winds blowing from the sea, and raised in long mounds or sandhills

(see 359), rising 30 or 40 feet above the highest wash of the waves. In the course of time, various creeping plants which flourish on sand have taken root on the surface thus raised; the seeds being carried by the wind. These have fixed the sand, and by their decay have formed vegetable mould, fit for the nutrition of other plants, such as grass, the screw pine, and the dwarf datepalm; and finally, as the spit has increased in width by the further accretions on the seaward face, the older surface has been brought under the plough, and has become arable land.

"A channel, however, remains through which the tidal waters pass and repass to the lake; and through which also the flood waters of the latter escape, when the surface of the lagoon has been raised by the rivers and streams that discharge into it during the rainy season. At such times its waters are almost or quite fresh; but during the greater part of the year, more or less sea-water is intermingled, especially in the neighbourhood of the outlet channel, rendering them saline or brackish. Year by year these lagoons become shallower, since most of the sediment brought in by the streams from the land is deposited on the bottom of the lake; and in the course of time, they will be filled up and will be converted into dry grassy plains. Some miles to the north of Pondicherry, near the village of Mercánum, there is such a lagoon, now nearly filled, and a great part of the low plain that extends at intervals along the Madras Coast, has been formed in this way and afterwards elevated."

To form some idea of the transporting power of the current of the River Mahanuddy, we learn from Mr. Blanford's abovenamed book, that it discharges into the sea about a half of the whole amount of water which it is estimated it receives in its basin as rain, which half, is 25 inches over a watershed of 40,000 square miles per annum. Also, that "in a great flood that occurred in July, 1855, and lasted for seven days, the quantity of water discharged by it was, in round numbers, 701,770 millions of cubic feet, or rather more than 3 cubic inches."

324. From False Point Lighthouse to mouth of Mypura River (inside of Palmyras Shoals), N. E. by N., distance, 26 miles, strikes across Dowdeswell Island and enters the sea

just to the south-east of Reddie Point, on its north end at $5\frac{1}{2}$ miles, passing $1\frac{1}{2}$ miles to south-west of False Point Harbour Fairway Buoy, 1 mile further on; deepens quickly to 7 fathoms at $6\frac{1}{2}$ miles, to 8 at 8 miles, and to 9 at 9 miles, green mud or oase; then gradually shoals over a bottom of green sand and mud, with rotten stones and broken shells, till, approaching the shore at the mouth of the river; shoaling rather quickly from 6 to 3 fathoms when near the shore.

325. From False Point Lighthouse to 5 fathoms on the tail of Palmyras Shoals (329), N. E., distance 30 miles, strikes the sea on the north-east edge of Dowdeswell Island at 5 miles, and quickly deepens from 1 to 7 fathoms, black sand; to 9 fathoms, green sand and broken shells, at one-third the distance, or about 10 miles; then gradually shoals to 7 fathoms, and suddenly to 5 fathoms, on the tail of Palmyras Shoals or Reef. This line continued, would cross this reef or shoal diagonally in $4\frac{1}{2}$ fathoms and fall into 6 fathoms at $2\frac{1}{2}$ miles from its tail: and very suddenly deepen into 14 fathoms, brown sand, black specks, and broken shells on its eastern edge: and this last should be the limit of depth of water in which it should be approached with safety, on this its eastern side: and a vessel would be, in 15 fathoms, on this line, 4 miles S.S.E. of the Palmyras Reef Buoy.

326. From False Point Lighthouse to Pilot's Ridge Light Station Buoy (305) (The P. R. Buoy), N.E. by E. $\frac{1}{8}$ E., distance 60 miles: strikes the sea at the tail of the flat off the tail end of Dowdeswell Island, at $1\frac{1}{2}$ miles distant crosses the flat, and at $3\frac{1}{2}$ miles distance, deepens suddenly from 3 fathoms into 7, black sand; and at 5 miles distance, into 10 fathoms, grey sand and mud; and carries about this depth for 20 miles, or about one-third the distance, over a bottom of soft, then olive, mud, and broken shells; then deepens gradually to 16 fathoms, coarse amber-coloured sand and broken shells, at half way; to $17\frac{1}{2}$ fathoms, coarse brown and yellow sand, $17\frac{1}{2}$ miles from the Pilot's Ridge Light Vessel (312), to

19 fathoms, coarse sand reddish specks, at 8½ miles from it; and to 22 fathoms at the Light Vessel. (Between these two latter (325 & 326), and in 18 fathoms, is mud, shells, and black specks: as also is there in 20 fathoms, 4 miles south of the Light Vessel.)

327. From False Point Lighthouse to Eastern Channel Light Vessel (286), N.E. by E. ½ E., distance 91 miles. This line of soundings will be nearly the same as the last line so far as that goes, but it deepens to 29 and 30 fathoms due south of the Ridge Light Vessel (312), after which it gradually shoals as it approaches the Eastern Channel Light Vessel.

328. **The Pilot's Ridge.*** A bank or ridge of soundings of, in most parts of it, clear sand, such as is not found in any other part of the head of the Bay, extending in a E.N.E. direction from off the shoals environing Point Palmyras (329), or towards the tail of the Western Sea Reef (336), chiefly composed of a gravelly sand with shells, and small stones here and there. It is the debris brought down by the currents of the rivers north and south of Point Palmyras, and which are carried, by those currents, far out to the eastward and N.E. by E.; possibly assisted by the heave of the sea. From the position of the Pilot's Ridge-Light (312) and for some miles to the eastward [even as far as the Longitude of the W. S. R. Buoy (259)]: and westward of it, the clean Ridge soundings of between 30 and 20 fathoms extend across its head for a distance of, in some places, over 15 miles in a north-west direction and northwards towards the Swatchway or Kell (338), to the westward of the tail end of the Western Sea Reef.

Its seaward, or south-east side, is rather steep, as you shoal suddenly from 28 and 29 fathoms, olive mud, into 23 or 24 fathoms clean sand, &c., when coming in from sea-

* For set of Sea Current, see secs. 378 and 379, by which there is but little southerly set of the sea; even in the freshets the set seems to be principally N. E. or Northward.

ward. North end of Ridge gives soundings of 20 to 23 fathoms, with bottom of sand, red specks, and shells, with bits of quill-like tubes of the shelly tunnels of marine boring worms of the Kannaka or other rivers, interspersed amongst it. Centre of Ridge; sand, red and black specks, and shells; in from 17 to 20 fathoms and more to the southward and westward, coarse amber and yellowish-coloured sand and broken shells. On its eastern limit, due east and 36 to 37 miles from Palmyras shoal, 8 to 10 miles from the Ridge Light and 36 or 37 miles east of Palmyras Reef, sand and shells, amber specks, pebbles, and coral, in from 24 to 27 fathoms water. (But see sec. (334), a table of Ridge Soundings). From this point the ridge soundings may be said to extend down S.W. almost to False Point, or at least 40 miles, and may be said to be 18 or 20 miles broad in a N.W. direction; so that it is a useful guide in cloudy weather and when no sights are obtainable, the soundings on it being so different from the mud deposits elsewhere: the Hooghly deposit being olive or dark olive mud intermixed with glistening sand-like steel filings, off the tails of all its sands and reefs.

329. **Palmyras, or the True Point, its Reef or Shoals.** Point Palmyras (Mypurra, the native name) is all low land and covered with Palmyra trees, but is seldom sighted by vessels, as it is surrounded by shoal banks thrown up from the rivers near, and on both sides of this Point. The shoals extend some 11 or 12 miles to the eastward of dry land, and running north and south for a distance of 7 or 8 miles, with a steep eastern edge; it is very unsafe for vessels to approach in less than 12 fathoms of water; and as the soundings off this shoal or reef is apt to be mistaken for those of False Point (323), vessels should not stand into less than 14 fathoms when trying to make False Point, and should then haul off N.E. when the water will shoal 2 or 3 fathoms and go on shoaling if off False Point; but it will deepen as many fathoms if the vessel is off Point Palmyras; so that to get into, and

keep on, Ridge Soundings (334) when leaving False Point for the Pilot Station (361), a vessel should steer N.E. by E., and if she deepens to over 27 fathoms, she should keep more to the northward and so keep on the Pilot's Ridge (328) until the Light Vessel (312), stationed on its Head, is sighted. The soundings on the inside or southern and south-western side of this reef do not deepen and shoal so quickly as on the eastern limits, and the soundings between it and the coast of False Bay to the west and south-westward are regular and not over 7 fathoms (see 324 and 325). The Palmyras Reef Buoy (319) is laid in 13 fathoms to mark its N.E. verge. Around and to the N.W. of this buoy is good anchorage for vessels caught in a westerly gale, but vessels seldom go near Balasore Roads nowadays except when driven there by heavy weather from the south-east or eastward. South end of shoal Lat. 20° 40′ N., East side 87° 11′ E., North end 20° 48′ N.

330. **Pipley Sand** or delta off the Soobunreeka or Pipley River (whose mouth is known by a Pagoda on its west side with a tope of trees near it) is 1 mile wide and 2 miles long, its longest axis running across the mouth of the river in the direction of the coast line here, or about E.N.E., and the river channel runs between its western end and the shore. Its centre is in Lat. 21° 53′ N., Long. 87° 21′ E., and the north peak of Nilghiri Hills bears West 31 miles. The coast line, which, below it, runs nearly east and west alters, above this spot, to about N.E. by E. and then N.E. away towards Hidjillee.

331. **The Western Brace.** A crescent-like stretch of hard sand, 30 miles long, and 1 to 1½ miles broad, which takes its rise on the shore about 10 or 12 miles below Hidjillee, where the coast line runs about N.E. and S.W.: half a mile broad, as it first starts away in a S.W. direction, it gradually curves round to the left till about 12 miles from the dry land, where it is trailing away south in its crescent-like course, and has increased its breadth to 1½

miles, in Lat. 20° 28′ N., Long. 87° 38′ E.: after which it gradually tapers away to half a mile, and less, at its tail, on a course of about S.S.E.: which is the direction taken by each and every sand, right across, to the eastward of the Mutlah, or, as far as the Swatch of No Ground, or to the eastward of the 89th degree of longitude. On the eastern edge of this sand, in Lat. 21° 33′ N., is the Western Brace Buoy (111), at a spot where the curvature of the sand alters its course from S.W. by S. to S.S.W., and where the least water across the Brace is $1\frac{3}{4}$ fathoms. This sand forms the eastern boundary of Balasore Roads or Bay (332): at the head of which, and running up between the head of this Western Brace and the main land, in former days, was a ship-channel named the Inside Channel: but which is now closed by this sand barrier.

332. **Balasore Bay or Roads,** so named from the town of that name, standing 6 miles inland, on the right bank of the River Boorabulling or Balasore: a wide expanse, bounded on the N.W. and S.W. by the coast line which forms a large segment of a circle with a radius of 21 miles, with soundings all over it of from 12 fathoms in its southern part to 4 or 5 fathoms all round, to within 2 or 3 miles of the coast line; on the N.E., E., and south, by the Western Brace (331) and head of Pilot's Ridge (328). In this Bay comparatively smooth anchorage may be found, and with good holding ground, specially to the southward in deeper water, where the southerly swell does not break.

With the compasses open to a radius of $21\frac{1}{2}$ miles, and with one leg in 12 fathoms, mud, sand, pebbles, and broken shells. Lat. 21° $6\frac{3}{4}$′ N., Long, 87° $20\frac{1}{2}$′ E., a circle may be described round these roads, and which, on a bearing from the central leg, of S. by W. $\frac{7}{8}$ W., passes just to the southward of Palmyras Reef Buoy (319), in 7 fathoms, just clear of the N.E. end of this Reef (329); and when bearing S.W. $\frac{1}{2}$ S., passes in 6 fathoms just outside the Kanaka Buoy (313); then right round the outskirts of the extensive flats off the coast, in not less than $3\frac{1}{4}$ fathoms;

passing just outside to the S.W. of the Balasore Buoy (224), on a bearing from the centre of N.W. ½ N.; it then passes 4½ miles due south (magnetic) of the west end of Pipley Sand, in 4 fathoms, on a bearing from the centre, of north; it then crosses the Western Brace (331) in 3½ fathoms, on a bearing N.E. from the centre; deepens to 10 fathoms in the Swatchway Channel (338) on a bearing of east from the centre; and to 20 fathoms 3 miles N.W. of the Pilot's Ridge Light Vessel, on a bearing from the centre of S.E. ½ E., sand, mud, and shells; it then gradually shoals as it draws round towards the Palmyras Reef Buoy as it passes the head of the Pilot's Ridge.

All the coast is low land, and it is bounded by extensive flats which prevent it from being seen in more than 2 or 3 fathoms; this latter depth being in some places 6 miles from dry land. From Palmyras Point the coast is planted with trees up as far as to near Balasore River, where it looks barren and is all sandy hillocks, continuing more or less sandy all the way round towards Hidjillee. At the head of Balasore Roads and in the vicinity of the head of the Western Brace, the soft oasy foreshore is a favorite place with the natives for beaching their small vessels on, in the event of their being caught in a gale hereabouts. False Bay coast is also a good place to beach a vessel on when compelled to do so: as the shore is bolder and at the same time soft. It is high water on full and change days at 8 hours in the south-western part of Balasore Roads.

333. **The Dhumrah River** is buoyed off, and coasting steamers now ply between Chandbally and Calcutta, carrying passengers, chiefly natives of Orissa. Also the Balasore River gives employment for one steamer between the town of that name and Calcutta. The route taken by the latter is across Balasore Roads (332), then between the Braces (332 & 331); across the head of the Eastern Brace (335) and up the Western Channel (343) to Cowcolly; then across into the Auckland Channel. The Chandbally steamers

either cross the tail of the Eastern Brace, and up the Western Channel, or cross right over into the Eastern Channel (356); according to the time of year and the sort of weather that may be prevailing.

The following is from one of the latest charts, corrected by Capt. Irving, S. S. " Sir John Lawrence."

From Chandbally to sea. Chandbally lies on the left bank of the Byturnee River, and about 30 miles (by the windings of the river track) E. by S. from the Kannaka Buoy, off the mouth of the Dhumrah, Kannaka or Kunka River. The channel of the river lies on the Chandbally, or left side, off the town; and runs N.W. for a mile, to Love Point; where the water shoals from 27 to 30 feet to 6 and 8 feet on a bar, which runs across from bank to bank above this Point: and deepens to 30 feet as it rounds the Point and follows down the left bank S. by E., 2 miles, as Hurreepore Reach; shoaling to 17 feet half way down, and to 8 feet on the bar at its southernmost end: where the channel crosses over to the opposite or right bank as it curves round to the left, in Long Reach, for a distance of 3 miles. Right through this reach there is 27 feet. The Long Reach, after curving to the left rather sharply from its junction with the last reach, runs east and ends N.N.E. at the acute turn off Sickle Point; where the channel of 21 feet crosses over to the left bank. The edge of the sand, off a creek, and half way round Long Reach, is marked by a black Buoy, at the narrowest part of the navigable channel, here only half the river's width.

Off Chandbally station and Goallee on the opposite side, and as far as Guire Point (the Point above these places) the channel extends from bank to bank: and so again off Hurreepore, opposite to, and N.E. of Love Point. In the next Reach Hurreepore, there is 17 feet: and the Sister Tree on its right bank marks where the channel begins to haul off towards that bank, and to shoal on the 8 or 9-foot bar of the crossing; then deepening to 14 feet at

Bor-arriah at the upper end of Long Reach and about half a mile below Sister Tree. From Bor-arriah the water deepens from 14 to 27 feet right past the black buoy until well down towards Sickle Point, when it shoals to 21 feet. This reach, Long Reach after leaving Bor-arriah, flows as it curves round the right bank, at first East and ends at N. by E. at Sickle Point.

The river, after rounding Sickle Point, flows down S. and then S.S.E. (almost in the opposite direction to what it flowed in the lower part of Long Reach); following the left bank for a mile and-a-half after passing Puttoriapal: but, unlike Hurreepore Reach, which ends in a bar, the water deepens from 21 feet off Puttoriapal to 33 and 36 feet ere it leaves the left bank in its S.S.E. course across to Angari, above which there is anchorage of 30 feet, below the tail of Sickle Sand. The eastern edge of Sickle Sand is marked by two red buoys, at the place where the channel narrows most.

After striking the right bank at Angari, the channel runs along the right bank as Pilot's Reach, at first, west; and ends at north; for about 2½ miles to Point Douglas. At half a mile west from Angari, the depth decreases to 14 feet, abreast of a black buoy, placed to mark the edge of the sand; after which it deepens to 24 feet, opposite the high bank and village of Budgerpore, where the channel runs N.W. This is not far from Noagaon Police station. At the termination of Pilot's Reach and above Point Douglas there is 1 mile of dry sand, called Pilot's Island: abreast of which the channel runs (still on the right bank) north, with 21 feet, until close down to the latter Point, where it shoals on some 4 to 8-feet lumps abreast a mark erected on the Point. There is a gut called Chapman's gut which crosses over to the left bank to the westward of this long dry sand (Pilot's Island). A large bushy tree is also a conspicuous mark due south, about one-fourth of a mile from the mark on Point Douglas.

After leaving Point Douglas the channel crosses the

junction of Jotha River, with this (Byturnee River), which is a short run, about 1 mile only, flowing to the southward of Lucheenarain Island: and abreast the N.W. end of this island the channel extends almost from bank to bank, with at first 18 feet, and when abreast of Kowriapal, deepening to good anchorage of 30 feet; as the river flows north past Guide's Creek on its left bank, and N.W. past Doorubpore and till Point Pearson on the right bank is south, and where the channel is running west still along the left bank. Off Point Pearson, which is the northern end of Lucheenarain Island and due east of it, the channel, still following the left bank, shoals to 21 feet, and narrows as it flows away south-east round the Island and ends at North Point. Guide's Creek and Point Pearson, west and east of each other, gives a good 30-foot anchorage. The Jooth River extends from Point Douglas round by the right bank S.S.E. to east at South Point, on which is erected McMaster's Mark. This Point and North Point, three-fourths of a mile N. by E. of it, marks the end of Byturnee River, and its junction with the Dhumrah River, flowing N.N.E. past its mouth. The Brahminee River and the Dhumrah are one and the same stream, only that the stream is called the Brahminee above this the junction of the Byturnee with it.

Besides McMaster's Mark, the entrance to the Byturnee is marked by three red buoys; the upper one on the south-east edge of the flats off the south-east extremity of Lucheenarain Island and south-east of North Point; the second on the western edge of a dry flat, one-third of a mile south-east of the first and the other on its edge to the north-west of this latter buoy; these two latter being actually in the Dhumrah River, and marking the right limits of the channel which runs N.N.E. in mid-river for half a mile after leaving North Point; striking in to the right bank after leaving the last or lowest of these three red buoys: so the channel curves sharp round North Point from south-east to north-east, which is about the course from it to Round Point, 1 mile distant. There is 16 to 19 feet to the north-west of

North Point, 30 to 40 feet in some places off it in the Rhumrah; but the water shoals to 19 feet when abreast the lower red buoy. The depth is 20 feet off Round Point and opposite a large creek on the left bank, abreast which the sand extends nearly half way across the river.

At Round Point the channel leaves the right bank, crosses over, and follows the left bank for 4 miles; passing two or three creeks in its N.E. to E. by N. course to, as far as Mutee River, just above the station of Dhumrah. Two miles E.N.E. of Round Point, on the same, right bank, is West Point, the western extremity of Kallibunge Island: an island over 4 miles long running west, with a boat channel south of it.

From Mutee River, where the sand off the north side of the island occupies half the river, to below the Tidal Gauge and Boundary Pillar of Dhumrah, there is anchorage of 21 to 24 feet; and here the channel crosses E.S.E. gradually to the right bank, and flows east and E.N.E. along the north side of the island, with a depth of 20 to 22 feet near the right bank; it occupying here about half the breadth of the river or about 600 yards; and after this it narrows to 350 yards, with 30 feet close in to the right bank, just above where the island ends in East Point; and then it widens out again as it runs due West about 3,000 yards to the 8-foot bar, on the northern limits of which is moored a black buoy called the Fair-way Buoy. This part of the channel runs to the north of mid-river, and has a width abreast Chandepaul Tree (which has a beacon on its summit) of 600 yards. Chandepaul Tree and its beacon is situated close down to the S.E. extremity of the land, before it trails away to the north-ward towards Balasore.

South-east of this Point, at a distance of 2,500 yards, is the northernmost extremity of Point Palmyras, before it trails away to the S.E. and then southward. There is anchorage of from 15 to 16 feet about one-third the dis-tance across from the land near Chandepaul Tree to Point

Palmyras, to the westward of the Fairway Buoy and above the Bar; and below the Bar and Fairway Buoy there is anchorage of from 19 to 24 feet with the palmtree of Point Palmyras bearing south.

From abreast East Point right down to the D Buoy, the channel runs E. ½ N., 13,000 yards, and is marked off by No. 5 or A Buoy, a black buoy laid in 12 feet on the southern edge of Kannaka Flat, close to the W.S.W. of Gordon's patch, which dries with less than 12 feet, and 2,150 yards E. ½ S. of Fairway Buoy, which are both on the extreme left limit of the channel; past No. 6 or B Buoy, a red buoy laid in 15 feet on the right limits of the channel and on the northern edge of Palmyras shoals. Its distance is 1,300 yards S.E. by E. from the A Buoy. Between those two buoys, there is anchorage of from 19 to 28 feet, the deepest water lying on the left or northern side of mid-channel and nearer to the black buoy.

The C Buoy, a black buoy laid in 13 feet, bearing E. by N. from B Buoy, distant 4,300 yards, marking the extreme left or northern limits of the channel, and like the A Buoy marking the southern edge of Kannaka Flat.

After leaving the B Buoy, the water gradually shoals from 20 to 13 feet as the C Buoy is approached, the deepest water being rather to the northward of mid-channel.

The D Buoy is laid in 10 feet on the right or eastern limits of the channel, and marks the extreme N.E. spit of Palmyras shoal. It bears from the C Buoy, E. ½ S., 600 yards, from Short's Tripod Beacon, W. by N., 2,100 yards, and from the B Buoy, E. ½ N., 6,000 yards. The channel widens out here, but has no more than 13 to 15 feet in it; and from this and the C Buoy, the channel turns off from E. by N. to N.E.; Short's Tripod Beacon erected on the northern extremity of a sand island south of the entrance, bears E. by S. ¼ S. from the D Buoy, and distant from it 2,100 yards: but the dry sand runs out from it, as a narrow spit, to the W.N.W. for 700 or 800 yards. There is 20 to 24 feet of water close to the westward of this spit, shoaling

gradually across to the westward to 10 and 11 feet, as the D Buoy is approached. From the extremity of this spit, the Beacon Sand strikes out north and follows round N.E. and east to the H Buoy, and forms the right limits of the South Channel onwards to its junction with the sea.

The E Buoy, black, is laid in 10 to 11 feet on the left or north-western limits of the channel and on the south-eastern edge of Kannaka Flat. It bears from the D Buoy, N. ½ E., 1,900 yards; from the C Buoy, N.E. ½ E., 2,600 yards. The north channel commences from this buoy; it being opposite to the S.W. extremity of Central Sand which separates the two channels. This S.W. extremity is connected with the N.E. extremity of Palmyras shoals (marked by the D Buoy) by a narrow shoal strip of 10 feet with 14 to 16 feet on each side for anchorage.

The G Buoy, black, is laid in 10 feet on the left limits of the south channel, and on the southern edge of Central Sand, the S.W. extremity of which crops out considerably between this buoy and the E Buoy last described. It bears from Short's Tripod Beacon, N. by W., 1,800 yards; from D Buoy, N.E. by E., 2,100 yards, from E Buoy, E. by S. ½ S., 1,650 yards, and from the C Buoy, E.N.E., nearly 3,750 yards; this line leads well clear of everything. The channel here is only 450 yards in breadth, the northernmost edge of Beacon Sand, forming the right limits of the channel to the S.S.E. of this buoy. There is anchorage of 16 to 17 feet, 500 to 700 yards S.W. from this buoy and outside the long 10-foot narrow strip (as noticed above) running down S.W. by S. from Central Sand to Palmyras shoal, marked where it joins the Beacon Sand by the D Buoy, the last bar of the whole river.

The H Buoy, red, is laid in 15 to 16 feet on the extreme N.E. edge of Beacon Sand and on the right or southern limits of the south channel, and marks its junction with the sea, called here Kannaka Roads. It bears from Short's Tripod Beacon, N.E. by E., 2,400 yards (which is the bearing and distance of G Buoy from D Buoy), from G Buoy,

E. ¾ S., nearly 2,100 yards. This last line being the best track for clearing the northern side of Beacon Sand until within 200 or 300 yards of G Buoy, when the course may be altered towards D and C Buoys (of course, this is when bound in), from Kannaka Buoy, S. by E., 3,700 yards. This line leads in not less than 14 feet well off the eastern side or edge of the triangular Central Sand.

The F Buoy, red, is laid in 10 feet on the right limits of the north channel, which runs away N.N.E. from the E Buoy and N.E. by N. after passing this buoy, then E.N.E. to the sea and the Kannaka Buoy (313). It lies midway between E Buoy and Kannaka Buoy and 150 yards to the N.W. of a line running N.E. and S.W. between them: and which line just cuts the north-western edge of central sand. There is a depth of 11 to 10 feet to well down to this buoy, but there is a long bar of only 9 feet between it and the Kannaka Buoy. A straight course may be steered for the Kannaka Buoy after passing this one, and as there are no other buoys to mark the eastern edge of Kannaka Flat after leaving the E Buoy, these two last buoys being right buoys should be kept well aboard on the starboard hand going out, to clear this flat.

The Central Sand which divides these two channels is almost triangular in shape, 2,700 yards in length, on its north-western side, in a line N.E. and S.W., 2,000 yards E. and W. on its southern side, and 2,400 yards N.N.E. to N.N.W. on its curved eastern edge; the least water is 5 feet, near its western edge.

It is high water full and change at Chandepaul Tree, opposite to Point Palmyras, at 9h. 30m. Rise and fall in the springs 8 to 10 feet, with a current in the freshets of 3 to 5 knots, and in ordinary springs 2 to 3 knots. The river is only navigated by small steamers and country coasters, but a lively trade is carried on between Chandbally and Calcutta; Chandbally being very conveniently situated as a "half way" stoppage between Cuttack and the sea. Steamers regularly ply

between Calcutta and Chandbally; and from thence there is also steam communication with Cuttack.

334. Soundings from Pilot's Ridge Station Buoy.

North, $2\frac{1}{2}$ miles:—21 fathoms, sand with red specks and shells.

——–, $5\frac{1}{2}$ miles:—20 fathoms, sand and mud with black and white specks, broken shells, and shelly tubes.

———–, 8 miles:—$19\frac{1}{2}$ fathoms, dark sand, mud, pebbles, and small shells.

———–, $13\frac{1}{2}$ miles:—17 fathoms, yellow clay and stones (due west 13 miles of tail of W. Reef).

———–, 20 miles:—8 fathoms, mud; off the tail of Western Brace.

N. by E., 6 miles:—21 fathoms, sand with reddish specks, broken shells, and broken shelly tubes.

———–, 10 miles:—21 fathoms, olive mud, coarse sand, and shells, also mud, sand, stones, and shells.

———–, 13 miles:—14 fathoms, mud and sand of a dark nature.

N.E., 10 miles:—22 fathoms (edge of ridge), sand, red specks and shells, then 23, dark sand and mud at 12 miles.

E.N.E., 12 miles:—22 fathoms, sand, red specks, and shells.

———, 13 to 14 miles:—24 to 25 fathoms, mud and sand.

East:—the same as last for 9 miles; then deepens from $23\frac{1}{2}$ fathoms into 24 to 27, sand and shells, amber specks, pebbles, and coral at 10 miles; then to 30 fathoms, mud at $12\frac{1}{2}$ miles.

S.E., $4\frac{1}{2}$ miles:—23 fathoms, sand with black and reddish speck, shells, and stones.

——, $8\frac{1}{2}$ miles:—25 to 32 fathoms, mud and sand with broken shells.

South, 2 to 4 miles:—20 fathoms, sand with black and reddish specks, shells, and stones.

South, 6 to 7 miles:—21 to 23 fathoms, fine sand with reddish specks and stones.

———, 13 miles:—deepens to 30 fathoms, olive-coloured mud.

S.W., 6 miles:—19 fathoms, sand, coarse and reddish specks and shells.

———, 10 miles:—18½ fathoms, fine sand with reddish specks and stones.

———, 16 miles:— 17 fathoms, coarse brown and yellow sand.

———, 20 miles:—17 fathoms, coarse amber-coloured sand and broken shells.

———, 20 to 40 miles:—17 fathoms, olive mud and broken shells to 18 miles east of False Point Light, where it is soft mud and broken shells.

S.W. by W., 6½ miles:—19 fathoms, coarse and reddish specks and shells.

———, 17 miles:—17 fathoms, coarse brown and yellow sand.

———, 32 miles:—10 fathoms, olive mud and broken shells.

———, 42 miles:—10 fathoms, soft mud and broken shells.

W.S.W., 5 miles:—22 to 20 fathoms, sand, reddish specks, mud, and shells.

———, 13 miles:—19 fathoms, dark sand, with mud, shells, and black specks.

———, 25 miles:—15 fathoms, brown sand, black specks, and broken shells.

———, 40 miles:—8 fathoms, green sand with broken shells (in False Bay).

W. by S., 15 miles:—18 fathoms, coarse sand with yellow and black specks and shells.

———, 25 miles:—14½ fathoms, yellow clay off the eastern edge of Palmyras Reef.

West, 10 to 12 miles:—18 fathoms, mud and sand, with black and white specks.

West, 25 miles :—15 fathoms, yellow clay.

W. by N., 11 to 12 miles:—18 fathoms, sand and mud, with black and white specks.

———, 18 miles :—16 fathoms, mud and sand, with black specks and shells.

———, 25 miles :—15 fathoms, mud, sand, black specks, small stones, and shells.

W.N.W., 19 miles :—14 fathoms, grey sand, mud, and shells.

———, 40 miles :—5 fathoms, mud, specks, and shells.

N.W. by W., 40 miles :—5 fathoms, dark sand and mud; some shells here and there.

N.W., 10 miles :—18 fathoms, grey sand, small pebbles, and broken shells.

———, 18 miles :—14½ fathoms, stiff mud or yellowish clay, pebbles, and broken shells.

———, 26 miles :—11 fathoms, olive mud, broken shells, and pebbles.

———, 40 miles :—5½ fathoms, dark sand and mud with broken shells.

N. W. by W., 35 miles :—6 to 7 fathoms, mud, shells, and sea-eggs.

N. to N.N.W., 3 miles :—21 fathoms, sand, red specks, and shells.

———, 6 miles :—20 fathoms, sand and mud, black and white specks, and broken shells.

———, 8 miles :—19½ fathoms, dark sand, pebbles, and small shells.

———, 14 miles :—17 fathoms, yellow clay and stones (westward of Swatch or Kell).

The shells are generally a small spirally-formed tapering shell, about half an inch in length; and another kind about one-fourth or half an inch in diameter, not unlike the half of a flattened cockle-shell. There are also pieces of pipe-like shelly formations resembling halves of the semi-transparent end of goose-quills. And these are generally found amongst the clean ridge soundings; they are evidently the shelly structure of some kind of marine boring worm.

335. **The Eastern Brace,** an extensive stretch of hard sand, which takes its rise from the land between Lat. 21° 40′ N., Long. 87° 50′ E., to 21° 45′ N., Long. 87° 55′ E.; and runs down 42 or 43 miles as far as Lat. 21° 23′ N. in a S.S.W. direction. It is in some places [abreast the Sola Buoy (71)] about 5 or 5¼ miles broad, and from the Sola Buoy northward has some long and extensive patches near its centre, which are dry at low water, but with a channel leading towards Balasore of 10 or 12 feet between them, which has been lately marked by nun buoys. It is marked, on its western edge, by the Sola Buoy; and further north, and abreast of a beacon half a mile to the northward on dry land, called Sandhill Mark, by the Eastern Brace Fairway Buoy (30); and its eastern edge, as far down as the junction of its tail with the Western Sea Reef (336) Head, by the Western Buoys of the Western Channel (353). Abreast of which [or the I Buoy (117)], there is not more than 1 fathom across it from E. to W., after which the soundings gradually deepen to 5 fathoms on its tail. A long band or belt juts out from it and runs up N.N.E. from its north-eastern edge called the Eagle Sand (339). The western edge of this Eastern Brace has a tendency at its lower part to, and does, beyond the 5-fathom line on its tail, curve round to the S.S.E. like all the others (see 359). Between the western edge of this sand and eastern edge of the Western Brace (331) there is a spacious channel, tapering off to nothing at its northern part, where is laid the Eastern Brace Fairway Buoy (30); but this channel is closed to all vessels excepting those light steamers plying to Balasore which cross this sand between the nun buoys on the edges of the dry patches. The soundings in it deepen from 2 fathoms, and a breadth at its head of three-fourths of a mile, to 5¾ fathoms, and a breadth of 4¼ miles abreast this, the tail of the Eastern Brace.

336. **The Western Sea Reef.** A bank or reef of hard sand, 18 to 20 miles long and 3¼ miles broad (within

the 5-fathom curve) stretching down S.S.E., being a continuation or extension of the Eastern Brace (335), the eastern or south-eastern edge of whose tail is connected with the north-western edge of the head of this sand by merely a bar with 21 feet of water on it, and half a mile broad. The least water upon the Western Sea Reef is near the junction with, or due east of, the tail of the Eastern Brace: where there is but $1\frac{1}{4}$ fathoms, with 6 fathoms between the western edge of this sand and the tail of the Eastern Brace, in the Swatchway or Kell (338). The eastern edge of its tail is marked by the Western Sea Reef Buoy (250), abreast of which there is $4\frac{1}{4}$ fathoms across the tail of this sand: the depths gradually decreasing as you go to the northward to the $1\frac{1}{4}$-fathom patch, as above mentioned. The western edge of this sand is steep to, deepening quickly from 4 fathoms to 6, 7, and 8 in the old Swatchway or Kell:—the channel running up between it and the tail of the Western Brace (331), here 8 miles broad; and on its tail it deepens from 5 fathoms into 10 fathoms, in a run due west of less than $2\frac{1}{2}$ miles, and this is a distinctive mark to know the tail of this reef from the tail of the Eastern Sea Reef when running east for the main ship-channel, the Eastern Channel (356) in the S.W. Monsoon and thick weather; as the soundings do not shoal so suddenly on the tail of the Eastern Sea Reef (342) as they do on the tail of this sand.

This same sudden decrease in the soundings on the tail of the Western Sea Reef is experienced down as far as Lat. 21° 00′ N., where a run of only $3\frac{1}{2}$ miles east alters the depth from 19 fathoms to 10 fathoms: whilst on this very line [the latitude of the South Channel Buoy (296)] the soundings only vary, from 12 or $11\frac{1}{2}$ fathoms at this buoy in mid channel, to 9 fathoms off the tail of the Eastern Sea Reef, on a run of 5 or 6 miles. This direction for feeling your way across the tails of these sands, as given in some of the old Directories, still holds good; and is the one practised by the pilot vessels after being blown off in a

gale of wind, and there is a probability of the light vessels and buoys being away from their positions.

From the 5 to the 7-fathom curve, on the tail of this Reef, in a S. by E. ¾ E. direction, is 4¼ miles; to the 10-fathom curve 7¾ miles; and to the 20-fathom curve 11 miles: but the tail of this Reef seems to be a turning point for both the two former curves: as they run up N.N.W. parallel with the western edge of the Reef and close on each other. The tail in 7 fathoms is in Lat. 21° 3′ 30″ N., Long. 79° 53′ E., 6 miles to the southward of the W. S. R. Buoy.

337. **The South Channel Middle Ground.** A long strip of unconnected sand running N.N.W. and S.S.E. parallel with the eastern edge of the Western Sea Reef (336), and separated from the upper part of that sand by a channel 1¾ miles broad. Its length is 12½ miles and breadth 1¼ miles, with a depth of water on it of from 3¼ fathoms at its northern end, to 3¾ fathoms at its southern end. Its eastern edge is marked by the three Western Channel Buoys, the Upper (153), the Centre (215), and the Lower (219) Middle Ground Buoys: and which is the western limits of the Western Channel (343). The channel, running up between its western edge and the eastern edge of the northern part of the Western Sea Reef, has a depth of from 6 fathoms at its lower part, to 4¼ fathoms at its northern part, abreast the north end of this Reef and the Middle Ground. This sand narrows the Western Channel from 8 miles below its tail, to less than 3¾ miles at its head.

338. **The Swatchway** Kell or Kill, which runs up between the Western Brace (331) and the Western Sea Reef (336), branches off between the tail of the Eastern Brace (335) and the head of the Western Sea Reef, running N.N.E. for the I Buoy of the Western Channel (343) as a fairway buoy, from 3 fathoms on one side to 3 fathoms on the other, is 1¼ miles broad, and is 5 to 6 miles in length.

339. **The Eagle Sand.** A long narrow spit or extension of the Eastern Brace (335), from 1 to ½ a mile broad, running up N.N.E. from the point of its junction with the Brace in Lat. 21° 38′ N., to its termination or point in Lat. 29° 45′ N., 87° 58′ E.: and has upon it a depth of water of half a fathom at its junction with the eastern edge of the Brace, 1 fathom half way up, and 2 to 2½ fathoms at its termination. A gut of water 1 mile broad separates it from the Eastern Brace Head, with a depth of from 2½ to 3 fathoms in it, and it is marked on its eastern edge by the A, E, and G Buoys of the Western Channel (343); and its eastern edge is the limiting western line of the Western Channel.

340. **The Mizen Sand.** An extensive shifting sand, dry in the centre at half tide, whose longest axis lies about N.E. by N. and S.W. by S., extending from the latitude of Cowcolly Lighthouse to the northward, to below the latitude of Saugor Lighthouse (54) to the southward: and lies in the centre of the estuary between Saugor Island (350) and the land about Hidgilee. Its western edge forms the eastern limits of the Western Channel and Cowcolly Roads, which is marked by the M Buoy, and B and D Buoys of the Western Channel (334), and its eastern edge by the Western Buoys of the Eden Channel; and forms the western limiting line of that channel. This sand, being higher up than the others, is liable to great alterations in its contour, greatly interfering with the permanency of the main ship-channels near, and now to the eastward of it.

341. **The Long Sand.** A more extensive sand than the latter, of which it seems to be a prolongation, being separated from it by a gut having now but 6 feet in it. It runs generally about north and south, and the main and central portion is dry at half tide, and some parts are only covered at high water. The swell is always seen breaking upon its southern end. It extends from above Saugor Lighthouse (54) on the north, to below the Lower Gasper Light Vessel

(166), or a distance north and south of 17 miles; and its greatest breadth, abreast the Upper Gasper Light Vessel (127), is, to the western edge of the spit running out into the Western Channel (334) from its western side, 6 miles: and it is marked on its western edge by the eastern buoys of the Western Channel, and on its eastern edge by the western buoys of Saugor Roads (349) and Thornhill's Channel. It is now almost joined on to the head of the Eastern Sea Reef (342), by reason of the Thornhill's Channel (346) and Reef Head Passage (345) closing up with silt. It extends from Lat. 21° 40′ N. and 87° 56′ E. to 21° 25′ N. and 88° 5′ E.

342. **The Eastern Sea Reef.** A long stretch of sand running down from its partial junction with the S.S.E. part of the tail of the Long Sand, in a S.S.E. direction, beginning in Lat. 21° 30′ N., Long. 88° 6′ E., and terminating in Lat. 21° 4′ N., and Long. 88° 9′ E. (on the 5-fathom limit), or about 28 miles in length, and 2 miles in breadth at its upper part [above the Spit Buoys (200 and 234)], to 2¼ miles below U. R. Buoy (247), then gradually narrowing at its tail of 5 fathoms, abreast the L. R. Buoy (266). It has a depth of water on it of 1½ fathoms across it abreast the Reef Head Passage Buoy; of 2 fathoms below it; of 3 fathoms abreast the Spit Buoy of Eastern Channel (234); of 3¼ at the Upper Reef or U. R. Buoy, and deepens to 5 fathoms across its tail at the Lower Reef or L. R. Buoy.

There are shoal patches on the head of this reef above the Reef Head Passage Buoy (190) and Thornhill's Patch Buoy (175), on which the swell breaks heavily in bad weather; these breakers may be seen from a long distance from a vessel's foreyard; and which served as a guide when running up channel after a breeze, and the buoys were liable to be out of position, in the times when the main ship channel was to the westward of the Middle Ground (352). The swell also makes itself felt on the tail of this reef, and in heavy weather it is to be avoided, if possible, by keeping well to the southward in deep water.

Its western edge is marked by the Reef Head Passage Buoy, the Western Channel Spit Buoy (200), and the South Channel Reef Buoy (228), eastern buoys of that channel, and forms the eastern limiting line of it. Its eastern edge, by the Spit Buoy (234), the Upper Reef Buoy (247), and the Lower Reef Buoy (266), western buoys of the Eastern Channel, and forms the western limiting line of that channel.

This reef, like the Western Sea Reef (336), has its eastern side shelving and its western side steep, though not so steep at its tail as is the western side of the tail end of the Western Sea Reef; and in shoaling on this reef from the eastward, the bottom gets harder as the water shoals, and another difference between the tail of this reef and that of the Western Sea Reef is, that, in going down S.S.E. upon it, you deepen from 5 to 7 fathoms in a shorter run, and to 10 fathoms in a longer run, than you do off the tail of the Western Sea Reef.

The pilot vessels cruise 3 to 6 miles off the tail of this reef in the S. W. monsoon. See 361, Pilot Station.

343. **The Western Channel.** Is a channel leading up from the South Channel (344) at its south end, and which is merely a continuation of it, to Cowcolly Roads, between the Middle Ground (217) of the Western Channel, eastern edge of the Eastern Brace (335), and its spit, formerly named the Eagle Sand (339), to the westward: and the Eastern Sea Reef Head (342), Long Sand (341), and tail of the Mizen Sand (340), to the eastward: and is marked on its western side by the Lower, Centre, and Middle Ground Buoys (219, 215, 153), and the I, G, E, and A Buoys (109, 68, 46, 9), and on its eastern side by the South Channel Reef Buoy (228), Western Channel Spit Buoy (200), Eastern Reef Head Passage Buoy (190), the Western Reef Head Passage Buoy (187), J Buoy (148), H Buoy (98), and D Buoy (22). It is nearly 30 miles in length from the head of the Eagle Sand, or the A Buoy, to the

tail of the Eastern Channel Middle Ground or the L. M. G. Buoy (219): and, with the South Channel (344); is, to the South Channel Buoy (296) (27 miles more), 57 miles. It is 5 miles broad at its lower part before it joins with the South Channel; 3 miles broad in a N.E. and S.W. direction from the north end of the Western Channel Middle Ground to the tail end of the Western Spit of the Long Sand, above which it is 3¼ miles broad; then narrowing again to 1 mile only at the tail of the Mizen Sand on its eastern side, and the junction of the Eagle Sand with the eastern edge of the Eastern Brace on its Western side (above the G Buoy); and continues this width the rest of the distance (over 8 miles). From the tail of the Western Channel Middle Ground, up north, to abreast of its head, the soundings in mid-channel gradually shoal from 6¼ fathoms to 4 fathoms, and from thence to the G Buoy (68), to 2¾ fathoms, where there seems to be a tendency of the tail of the Mizen Sand to join with the Eastern Brace, as the soundings deepen again above this point to 3 and then 4 fathoms in places as the channel runs up the other 8 miles. The general direction of mid-channel is, for the lower part, N.N.W. till abreast the I Buoy (109), then north to the next western buoy, the G Buoy; and for the rest of the distance N. by E., ¾ E.: and throughout its entire length the deepest water is always to be found on its eastern side, as notably in all the other outlets to the river currents. This channel is no longer used as a ship-channel, since the eastern route up by the Eastern (356) and Gasper Channels (351) afford better water and room, and is so well lighted; and, too, since the anchorage at Kedgeree has quite silted up. It is highwater on full and change days at 9h. 4m. in the lower part, and a rise of 12 feet: and at about 10h. 30m., and a rise of 14 feet in its upper part; the main body of the stream running in the direction of the different parts of the channel, excepting at the Reef Head Passage and below the tail of the Mizen Sand, where the flood-tide will be found to set into the

channels to the N.N.E. and the ebb-tides generally from them. But in the lower part they are found to have a tendency to revolve with a watch hands, the last of both tides turning off to the right, more especially the ebb-tide.

344. **The South Channel** or the Old Fairway Channel. Is a continuation from the lower part of the Western Channel (343) above described, and is marked on its western side by the Western Sea Reef Buoy (259), on its eastern side by the South Channel Reef Buoy (228), and its sea termination by the South Channel Buoy (296). The eastern edge of the Western Sea Reef (336) being its western limits, and the western edge of the Eastern Sea Reef (342) being its eastern limits. This channel, together with the lower part of the Western Channel, was formerly denominated the Fairway Channel.

The soundings from 12 fathoms at its south or sea end gradually decreases to 6¼ fathoms at its junction, with the Western Channel abreast the L. M. G. Buoy (219): and, as in all the other channels, the deepest water lies on the eastern side of mid-channel. It is 27 miles in length, and is from 5 fathoms on its eastern limiting line, the western edge of the Eastern Sea Reef (342), to 5 fathoms on to its western limiting line, the eastern edge of the Western Sea Reef, at its lower part, 8½ miles; and at its upper part, just below 5 fathoms on the tail of the Western Channel Middle Ground (217), 8 miles broad.

The tail of the Middle Ground, with 5 fathoms on it, extends down for 3 or 4 miles below the Lower Middle Ground Buoy till abreast or 1 mile below the South Channel Reef Buoy (228), with 6 fathoms between it and the eastern edge of the Western Sea Reef, and likewise for three-quarters of a mile south-east of the last mentioned buoy.

345. **The Reef Head Passage** (now closed) has its south-western entrance marked by two buoys, the Lower Eastern (190), and the Western (187): and is a gut or

channel running up in a somewhat tortuous direction, generally about north-east,—that is, taking it and the Thornhill's Channel (346) as one channel. It, with the Thornhill's, separates the Eastern Sea Reef Head (342) from the tail and south-eastern extremity of the Long Sand (341).

346. **The Thornhill's Channel.** A channel running down from Saugor Roads (349), and joining the Reef Head Passage (345), in a general south-west direction for 5 miles, and although the channel has silted up and is closed for navigation, three of its buoys are retained in position—the Upper Thornhill's (122), the Thornhill's Patch or Prong Buoy (175), and the Lower Thornhill's Buoys (161 and 162). The Thornhill's Patch or Prong Buoy, the easternmost, is moored in the constricted part of, and marks the narrow gut or channel running down from the south-west corner of Saugor Roads (349) to below, and west of, the Bell Buoy (209). This channel separating the Middle Ground (352) on the east from the Reef Head (342) and tail of the Long Sand (341) on the west.

347. **Saugor Flat.** A sand and mud flat, very steep to round its whole extent; commencing to crop out from Saugor Beach from just above the latitude of the Lighthouse and stretching nearly up to Dog Creek, below Black Point, a distance of 4½ miles: has a breadth of (from dry land) over a mile; and which dries at half tide for a considerable distance from the shore, especially between the two Saugor Flat Buoys (18 and 51), which is its broadest part. The line of these two buoys should not be encroached upon, as the water shoals very suddenly from 5 into 2 fathoms on the western and north-western edges of this flat, which is the eastern limiting line of the upper part of Saugor Roads (349) and the lower part of Bedford's Channel.

There is a gut of good protected anchorage for foul weather, running up N.N.E. for 3¼ miles between this flat (on which the swell breaks and expends itself) and

the eastern edge of Bedford's Sand, with an average depth of 7 fathoms, shoaling gradually on either side as either the flat or the sand is approached, though rather quicker near the flat on its eastern side: with a width of a mile or three-quarters of a mile between the 5-fathom limits on each side: it is marked on its western side by the Apex Buoy (36), Lower Western Bedford's and Centre Western Bedford's Buoy, and on its eastern side by the Centre and Lower Saugor Flat Buoys. This gut was, not long since, the main ship-channel, but its northern outlet has silted up. From Dog Creek to above the Centre Saugor Flat Buoy, the eastern limiting line of 4 fathoms is 700 yards from dry land on Saugor Beach, the flat narrowing here.

348. **Middleton Sand.** An extensive stretch of sand which crops out from Saugor Beach from just below Saugor Lighthouse (54), and after running a little distance up Saugor Roads (349), as the Middleton Spit, it follows right round the south end of Saugor Island,* environing Middleton Point and Saugor Point as it stretches out for nearly 6 miles; likewise to near the Upper Gasper Light Vessel (127), and even to well down towards the Lower Gasper Light Vessel (166); when it closes somewhat on the southern end of Saugor Island (350), abreast the tall grove of Casuarina trees, Dooblat Grove (77); and ends in its junction with the northern part of Edmonstone Sand (334), a sand which formerly was an island covered with scrub.

Its western and southern limits are marked by the Upper Middleton Buoy (58), the Middleton Spit Buoy (80), the Upper Eastern Gasper Buoy (104), the Centre Eastern

* Since the above was written, the spit of this sand has grown out to the southward, considerably narrowing the channel, and necessitating the moving in that direction of all the eastern buoys; hence care is required in using these directions for Saugor Roads as they become old, as changes go on continually in the river bed above the Lower Gasper Light Vessel.

Gasper Buoy (133): and also, though some distance from it, the Lower Eastern Gasper Buoy (142).

Its outermost edge, with 18 feet upon it, is 1¼ miles from low water-mark on Saugor Beach: this is just below the Upper Middleton Buoy; 3¼ miles from it, abreast the Saugor Anchoring Buoy (93); 6 miles at the Centre Eastern Gasper Buoy (133), and 2½ miles abreast of Dooblat Grove, when it may be considered as ending.

At its upper part and about three-quarters of a mile to the north-east of the M. S. Buoy, there is not more than 13 feet of water with a gut of 21 to 30 feet between it and the beach; but nothing less across it than 16 feet, in a line between the Upper Gasper Buoy and Saugor Lighthouse (54): which depth leads into and seems to be a continuation of the above mentioned gut, in which, after deepening to 22 feet, deep water, 5 to 7 fathoms, will be found by steering for the Lower Saugor Flat Buoy (51). Below this line, and abreast the Upper Eastern Gasper Buoy, the water shoals on the sand to 12 feet, and due east of the latter buoy and due north of the Centre Eastern Gasper Buoy, is a patch of only 6 feet, on which there are heavy breakers in blowing weather.

There is a track of 11 or 12 feet right along from west to east abreast of Saugor Beach at about 1 to 1½ miles from the shore, terminating, to the eastward, in 19 feet when in a line, or a little to the eastward of a line, between the Lower Eastern Gasper Buoy and Dooblat Grove, in a gut running down to the Lower Gasper Light Vessel (166), a continuation of the Eastern Channel (356).

The flood-tide sets strong on to this sand until above the Middleton Spit Buoy, and the ebb away from it, say N. and S.

349. **Saugor Roads or Anchorage.*** A channel running up N.W. ½ N. (The Gasper Channel Course) from the Upper Gasper Light Vessel (127) to abreast the Middleton

* For recent narrowing and shoaling changes in the lower part of this Roadstead, see footnotes to (58), (80), and (104).

Spit Buoy (80), then N.N.W. and N. by W., from abreast the Upper Middleton Buoy (58) to the Apex Buoy (35), where it terminates and joins the Eden Channel: its length is, from the Upper Gasper Light Vessel to the latter buoy, about 10½ miles, and its breadth is (within the limits of 24 feet) about 1¾ miles below the Apex Buoy, 2¼ abreast Saugor Lighthouse (54), where is the usual anchorage for deep vessels; narrowing again to five-eighths of a mile, when below the Long Sand Spit Buoy (85) and abreast the Middleton Spit Buoy: and keeping this breadth, and half a mile in some parts, right down past, and close to, Saugor Anchoring Buoy (93), and ends in 25 feet at the U. Thornhill's Buoy (122); the mid-channel depth gradually shoaling from 34 feet at the Long Sand Spit Buoy (85). But a depth of not less than 18 feet may be found with a channel 1⅜ miles broad from the Long Sand Spit Buoy down to below Saugor Anchoring Buoy, where it suddenly widens out to 3 miles between the Upper (104) and Centre Eastern (133) Gasper Buoys, as its eastern limiting line; and the Saugor Anchoring Buoy and Upper Thornhill's Buoy (122) as its western limiting line: the depth gradually decreasing from this deep gut, running down along the steep eastern edge of the Long Sand, as the eastern side of the channel or western edge of the Middleton Sand (348) is approached; and the bottom gets proportionally harder and more sandy as the water shoals. There is good holding ground, muddy in the deeper guts or holes, everywhere over the sub-marine delta.

In the upper part of this Roadstead there is anchorage of 45 feet abreast Saugor Lighthouse (54), and in a line between the Lower Saugor Flat Buoy (51) and the Upper Middleton Buoy (58). Although in ordinary weather there is safe anchorage here, yet in heavy gales a very considerable swell rolls in at high water. It is high water full and change at 10 hours, with a rise of 15 feet in the springs and 12 feet in the neaps: at the lower part, or at the Upper Gasper Light, it is high water a quarter of an hour

earlier, rising 14 feet in the springs and 11 feet in the neaps. The tide runs about fair up and down Saugor Roads from Saugor Anchoring Buoy upwards: but below it, where the dry Long Sand permits it, the tide has a tendency to flow round the compass, especially the last of the ebb, when, as all over the submarine delta, it sets S.S.W. and S.W.

The western marks and limits of the channel are, coming in from sea, the Upper Thornhill's Buoy, the Saugor Anchoring Buoy, the Long Sand Spit Buoy, and the Lower Lloyd's Buoy (41)a,—ll on the eastern edge of the Long Sand (341), which is steep to: and the eastern limits and marks are the Upper Eastern Gasper Buoy, the Middleton Spit Buoy, the Upper Middleton Buoy, on the western edge of Middleton Sand; and the Lower Saugor Flat Buoy on the south-east edge of Saugor Flat (347).

The marks by night for making the deep water anchorage are to keep the two Gasper Lights in one until Saugor Lighthouse bears N. by E. ¼ E. to clear the Middleton Spit, when the course must be altered to N. by W. ½ W. or N. by W. until Saugor Light bears N.E. easterly, which places a vessel in from 30 to 34 feet above the Long Sand Spit Buoy. There is more room and good anchorage higher up and above the Upper Middleton Buoy or after Saugor Light is brought to bear between E.N.E. and E.S.E., where vessels can approach to within three-fourths of a mile of Saugor Beach in 30 to 35 feet of water; but it is all a matter of judgment and guess by night, as there are no leading lights to guide vessels after running above the Long Sand Spit Buoy, abreast of which the line of two Gasper Lights in one cuts the dangerous and steep eastern edge of the Long Sand. The Lower Gasper Light must not be opened to the eastward of the Upper Gasper Light any more than a quarter of a point as three-eighths of a point cuts the Middleton Spit Buoy.*

* Since the above was written, the Middleton Spit has so far encroached on the channel in the lower part of Saugor Roads, that all the eastern buoys have been moved further out, so narrowing the channel. Thus

The current runs in the springs from 2 to 4 knots flood and ebb, and in the freshets the ebb runs sometimes good 4½ or 5 knots in the springs in the upper part of the roads.

There is an electric telegraph station near the Lighthouse, which reports passing vessels, and hoists, at the yard arm of the flagstaff, storm-signals on the approach of bad weather; see Storm-signals (394).

350. **Saugor Island (Western Division).** Is an island of low alluvial soil covered with impenetrable jungle except some clearances on its eastern side; is intersected with numerous creeks or khalls, and infested with tigers, deer, and other wild animals of the Soonderbunds; is 41½ miles long from Mud Point on its north to Sidney Point on its south-east end, and 40 miles from Mud Point to Middleton Point or Saugor Point on its south-west end; and is from 1 mile at its upper end to 12 miles broad at its lower or southern-most end, from Sidney Point on the east round Saugor Point on its south side, to Middleton Point on the western extremity of its southern coast line.

Its western shore forms the eastern limits of the estuary of the Hooghly River; its southern shore faces the sea, and is enclosed by the Middleton Sand (348); in some places 6 miles broad; and on which the rollers break heavily in some parts. Its eastern coast line forms the western limits of the Burratullah River or Channel-creek: formerly a deep navigable channel, whose outlet was Lacam's Channel; but which now seems to be almost filled with silt, as there is not more than 3 or 4 feet of water in it in that portion which flows round Mud Point and N.W. into the Hooghly River. Its western shore generally lies N. by E. and S. by W. Its southern shore about E.S.E. and W.N.W. Its east-

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we see what little dependance can be placed in these present directions, as time rolls on, for all the channels and sands, at least above the Lower Gasper Light. Reports and Surveys over six months old should be cautiously made use of, as the bed of the river is perpetually changing. *See* footnotes to (58), (80), and (104).

ern shore about N. and S. from Sidney Point north for 20 miles, and about N.W. and S.E. hence to Mud Point.

A large creek divides its southern shore in two parts as is plainly seen from below the M. S. Buoy, as the jungle is growing right down to the water's edge in a dark soil on the western side of it, while all the beach to the eastward is white sand, with breakers rolling up on it with great force in blowing weather. The point on the western side of this creek is Saugor Point. Above this sandy beach looms up a large grove of tall Casuarina trees called Doob-lat Grove (77). In Lat. 21° 36′ 30″ N., Long. of centre 88° 7′ E., running E. by N. and W. by S.: and which are seen in a line from above Saugor Anchoring Buoy (93), just on with the northern bank of the creek abovementioned.

Its eastern and southern extremity, Sidney Point, is in Lat. 21° 35′ 45″ N., Long. 88° 9′ 30″ E., and its northern extremity or Mud Point is in Lat. 21° 56′ 15″ N., Long. 88° 8′ E.

Saugor Lighthouse (54) and telegraph station stands about half a mile inland from Middleton Point.

There are some large villages on the eastern side of Saugor Island, where the land is cleared and cultivated: also some large Government salt works, where shipwrecked mariners have found relief in their distress. As the jungle is impenetrable and infested with tigers, no attempt should be made by a shipwrecked crew to cross the island to the Lighthouse; but the coast line must be followed round and the creeks crossed in preference. See Houses of Refuge (390).

351. **The Gasper Channel.** The main ship channel running N.W. $\frac{1}{2}$ N. from the upper part of the Eastern Channel (256) to the lower part of Saugor Roads (349). In length, from Light Vessel to Light Vessel, $5\frac{3}{4}$ miles; and breadth, from head of Middle Ground to tail of the Middleton Sand (348), and from S.W. to N.E. in 18 feet on their edges, $1\frac{1}{4}$ miles; increasing to 2 and 3 miles below it.

It is marked on its western side by the Gasper Station Buoy (172), the Lower Western Gasper Buoy (156), the Centre Western Gasper Buoy (138), and the Upper Western Gasper Buoy (127); the three former just off the N.E. edge of the head of the Middle Ground (252), whose edge is the western limits of the channel; and the latter buoy, at present, on account of the sand washing away, over a mile to the northward of 18 feet on the head of the sand. On its eastern side, by the Lower Eastern Gasper Buoy (142), the Centre Eastern Gasper Buoy (133), and the Upper Eastern Gasper Buoy (104), the two latter just off the south-western edge of the Middleton Sand, whose edge forms the eastern limits of the channel, and the former in 22 feet about a mile S. and S.E. of the tail of that sand. It is also marked at its south-east end by the Lower Gasper Light Vessel (166), the channel lying on either side of her, preferably to the northward and eastward of her: and its north-west end by the Upper Gasper Light Vessel (127), the channel lying to the N.E. of her.

The best water through the channel, 19 feet, is to be found by keeping in a line between the two Light Vessels, and after passing the Upper one, where there is shoal water for a mile or two, to keep the Lower Light on with the Upper one till Saugor Lighthouse bears N. by E. ¼ E. [*See* Saugor Roads (349).]

The sea runs high in this channel, so that it is not safe to attempt running through it in the S.W. monsoon, until the moon has well risen or has been set some time, when the tide, isin at Kedgeree and has, consequently, risen well here. Both flood and ebb sets much across the channel, especially when the tides grow old, or is in the last quarter of ebb or flood. It is high water on full and change days at the Lower Gasper Light Vessel at 9h. 38m., and rise of tide in springs is 13 feet; neaps 10½ feet.

The edge of the head of the Middle Ground is steep to, and the line of western buoys must not be passed. The breakers on the head of the Middle Ground are seen about

$1\frac{1}{2}$ miles west of the Lower Western Buoy, also about the same distance east of the Upper Eastern Buoy on 6-foot patches of hard sand.

The water in the channel shoals gradually from 27 feet abreast the Lower Gasper Light Vessel to 19 feet, the least water in the narrowest part of the channel between the two Centre Gasper Buoys; it then deepens a quarter of a fathom; but carries no more than 21 feet, till well past the Upper Light Vessel and well over towards the eastern edge of the Long Sand.

There is generally too much sea in this channel to stay a ship in the S.W. monsoon, so that, unless the wind allows the vessel to lay through N.W. $\frac{5}{8}$ N., with an allowance for tide, its passage should not be attempted.

352. **The Middle Ground.** Is a sand, in length N.N.W. and S.S.E., within the limits of 18 feet, $9\frac{1}{4}$ miles, and in breadth $2\frac{1}{8}$ miles at its greatest, due west of the Lower Gasper Light Vessel (166), or about two-thirds of the entire length from its tail end. It narrowing towards each end in proportion to its distance from them. Its N.N.W. end is marked on its eastern side by the Centre Western Gasper Buoy (138) and the Lower Western Gasper Buoy (156); and its western edge by the Thornhill's Patch Buoy (175), moored in the narrow part of the gut running down between this sand and the head of the Eastern Sea Reef (342) and just to the westward of its broadest part. Its eastern edge in 24 feet, three-fourths of a mile south-west of the Lower Gasper Light, is marked by the Gasper Light Station Buoy (172), by the Lower Middle Ground Buoy (194), and the Bell Buoy (209), which latter also marks its tail in that depth, with 23 feet across it, east and west, and with 24 feet across it half a mile further south: the depth gradually increasing off its tail to the S.S.E., to 30 feet at the distance of 3 miles south of the Bell Buoy, and $3\frac{1}{4}$ miles due west of the Intermediate Light Vessel (238), with 2 or 3 feet more water on either side of its tail.

The depths gradually increase seaward, and as the soundings decrease gradually from the Lower Gasper Light Vessel down along it, the lead is a good guide: but its north-eastern edge is steep to, so is its western edge in the upper part; but the channel to the west of this sand is an unauthorised one.

There is a patch of 6 feet on the head of this sand, well over on its western side, with heavy breakers on it in the S.W. monsoon.

Its north-eastern edge forms the south-western limits of the Gasper Channel (351), and its eastern edge forms the western limits of the Eastern Channel. A heavy ground swell rolls upon its tail, making it dangerous to approach in bad weather; for vessels, when towing out in 5 fathoms, have been known to strike the ground in 9 feet over their draught. The Intermediate Light Vessel was first moored off its tail, but she was much damaged in the breakers during a hard gale, and had to be removed into deeper, and consequently smoother, water over to the eastward.

The Lower Gasper Light is a guide by night to clear the eastern edge of this sand, which should not be brought to bear to the right of N. ¾ W., or of N. by W., if in a deep ship and a heavy sea running, both to keep clear of the heavy rollers, which are liable to break and poop the vessel when running in, and to avoid bumping: so that it is best to steer out to the eastward after passing the Intermediate Light Vessel, and run up in a line of her and the Lower Gasper Light Vessel; for if compelled to hug the Middle Ground with a scant wind, it is useless running for the Gasper Channel, where a vessel has to haul up, if the sea is rough (it must be remembered) and flood-tide strong, as many as 3 or 4 points to get through it.

353. **Saugor Island (Eastern Division).** Also a distinct island, separated from its western division by channel-creek or the Barratullah River. It stretches much further to the southward than its neighbouring half, its

southernmost part being Seyer Point; and the coast line to the eastward of it, trends to the E. by S. 2½ miles from this Point, which is in Lat. 21° 31′ 30″ N., Long. 88° 14′ 15″ E.; and House of Refuge No. 1 is 1 mile above it, and just to northward of Jackson's Grove, which is a tope of tall trees plainly visible from the Lower Gasper Light Vessel (166) (*see* 171).

From Seyer Point to Pitt's Point, the coast line runs round from N., then N.W., and round by S.W. to Pitt's Point, crossing three creeks. From Seyer's Point to Pitt's Point across the flat, is N.N.W. 4 miles; and in the same direction 6½ miles further is Preston's Point; and from there to the Point at the entrance to the Dooagra River and crossing the creek, on the northern bank of which is House of Refuge A, it is 5 miles N.E. by N.

From Preston's Point the Dooagra River separates the island from the main land, and runs somewhat like the course of channel-creek, after it leaves Mud Point: after running first E. for 2 or 3 miles, it turns away to the S.E. and joins the Subtermooky River, which runs down the eastern side of this island and separates it from Lothian Island.

The Island from N. to S. is 14 miles, and from E. to W. 5 to 6 miles. Like its western division it is crossed and intersected by creeks and overgrown with jungle, and is infested with tigers; its sea face is lined with sands and shoals extending down and terminating in Saugor Sand (255). [*See* Refuge Houses (390).]

354. **Edmonstone Sand.** Formerly a low island on which stood a wooden lighthouse, that was swept away by a storm-wave during a cyclone: an accumulation of sand on the head of Saugor sand, with extensive dry patches, which are seen dry at half tide, and on which the sea breaks heavily, extending right down from off Sidney Point S.S.E. to a distance of 10 or 12 miles, or in a line between Seyer Point and the Lower Gasper Light, or N.E. ½ E. from this

Light. The trees on Seyer Point are seen across the southernmost breakers in clear weather; so that these breakers may serve as some sort of a guide when running up the channel after a storm, and the light vessels are away from their position, to fix the position of the Lower Gasper by Dooblat Grove (137), then bearing N. (*see* 170).

N.E. of the Lower Gasper Light Vessel (166) and just to the eastward of a line between a line of Dooblat Grove and Upper Saugor Sand Buoy (181) and about 5 miles N. ¾ W. of the latter, its western dry edge is within a mile of 25 feet in the channel, so steep to is its edge, like all the western edge of Saugor Sand (255): and which in fact is but a continuation of this sand, at least on its eastern prong, as far down as the Intermediate Light Station Buoy (224), where the depth across the sand has deepened gradually to 18 feet.

355. **Saugor Sand.** An extensive stretch of sand and, including Edmonstone Sand (254), running down seawards in almost a straight line on its western edge, in from 3 feet abreast Lower Gasper Light, to 30 feet of water S. by E. ½ E., 33 miles from the dry land of Sidney Point on the south-east end of the western division of Saugor Island (259), before 30 feet of water can be found across its tail, in Lat. 21° 4′ N., Long. 88° 22′ or 23′ E.; and about 27 miles S. by E. from the south side (east of Seyer Point) of its eastern division; from which it also extends, after it has been crossed by the water from the Burratollah River or channel-creek uniting with the head of Lacam's Channel: but this part, or the *eastern prong* of Saugor Sand has more water on it than that part adjacent to the Eastern Channel (256) by 1 or 2 fathoms.

It is steep to on its western edge all the way up and down until down near the Lower Buoy; the water shoaling rapidly 30 to 20 feet or 10 feet in three-fourths of a mile at the Lower Saugor Sand Buoy (254), 20 feet in half a mile at the Centre Saugor Sand Buoy (206), or

from 30 to 10 feet and from 25 to 10 feet in one-third of a mile abreast the Upper Saugor Sand Buoy (181), which is its steepest part. But on its eastern edge, from 5 fathoms on the western limits of Lacam's Channel, it shoals very gradually indeed in some parts, deepening a little as the western portion is approached.

It is over 10 miles broad in the latitude of the Lower Gasper Light (from 5 fathoms on one side to 5 fathoms on the other), and gradually gets narrower, until, at abreast the Intermediate Light (338), it is 7 miles, and at the Lower Saugor Sand Buoy (254) it is 6½ miles across from one channel to the other.

Its shoalest water is everywhere from 1 mile to 1½ miles of its western edge. There is only 3 feet on it abreast the Upper Saugor Sand Buoy off the tail end of Edmonstone Sand, 9 feet abreast the Centre Saugor Sand Buoy (206), 17 feet abreast the Intermediate Light Vessel, with 18 feet abreast her Station Buoy; and 22 feet across it at due east from the Lower Saugor Sand Buoy: but here the shoalest part is on its eastern side, called the eastern prong of Saugor Sand, the water shoaling gradually from 30 feet on the western edge of the sand (see 258).

In the earlier part of the present century the tail of this channel used to be crossed, and the channel to the eastward, Lacam's Channel, navigated by The Honorable East India Company's ships: one of which at a draught of about 21 feet actually sailed from the tail of Saugor Sand, up this channel, and through Channel-Creek to Mud Point, in one tide: and under very unfavourable circumstances too, there being few, if any, buoys to guide those navigating her: but the Channel-Creek being long since closed to vessels of large draught, and the present main ship channel *viâ* the Gasper being so good (having not less than 19 feet in it), Lacam's Channel is discarded and left unsurveyed. It was also much used by men-of-war in the last century during our struggle for supremacy in Indian waters.

The western limits of this sand is marked by the Upper,

Centre, and Lower S. S. Buoys; also by (though some distance off it) the Intermediate Light Vessel and her Station Buoy.

356. **The Eastern Channel.** The main ship channel leading to and from Calcutta, extends from the Lower Gasper Light Vessel (166) to the Eastern Channel Light Vessel (286), S. by E. ⅝ E., distance 25½ miles; is 3¼ miles broad at the Lower Gasper Light Station Buoy (from 25 feet on each side), right down to the Bell Buoy (209), and Centre Saugor Sand Buoy (206), below which line the extremity of the Middle Ground (252) allows the channel to widen to 8½ miles, and to 10 miles below the Upper Reef Buoy (247). From the Lower Gasper Light this 25-feet line strikes away N.E., and joins that running up along the steep western edge of Saugor Sand (255) about east by north 2¼ miles of the Lower Eastern Gasper Buoy (142), or the line (185). The 5-fathom channel commencing at the Upper Saugor Sand Buoy (181) with its eastern limits running down along the steep western edge of Saugor Sand, past the Centre Saugor Sand Buoy to the Lower Saugor Sand Buoy (254), S. by E. ⅞ E., 16 miles; and then S.E. 12 or 13 miles: its western limits gradually opens out from it: thus widening the 5-fathom channel to 2¼ miles; abreast the Centre Saugor Sand Buoy and Bell Buoy, to 4½ miles; just below the Intermediate Light Vessel (238), or abreast the Station Buoy (244), to 7 miles; and to 11½ miles at the Lower Reef Buoy (266).

The deepest water is found on its eastern side not far from the edge of Saugor Sand: where the bottom is generally a soft but sticky clay, in which the lead often sinks so deeply that the line parts before it can be drawn out, unless it is a good one. So that the nature of the bottom will, independent of the depth, give timely notice of a vessel's proximity to the western edge of Saugor Sand, and that it is time to tack. And to the westward; the water shoals gradually, both on the eastern edge of the Middle Ground, as well as on the eastern edge of the

Eastern Sea Reef (342); and this may be said to be the character of all these channels (see 359) and their dividing sands, even from the Western Brace (331) to the westward, to the Subtermooky or Lighthouse Sand to the eastward: caused, I suppose, by currents of fresh or brackish water running to the southward from the channels above, meeting and eddying vertically with the heavier sea water running west over the tails of the sands, so that a scooping out and constant disturbing process is always at work: the sandy portion of the silt brought down by the river being worked up on the reefs, like the shingle and deep sea shells are washed up on a sea beach by the action of a never-ceasing ground swell, whilst the clayey portion is deposited in deep water; as the fresh water, in which it is in some way suspended, is acted upon by the salt of the sea water which crosses its path.

And I believe the sands off the mouth of the Hooghly, by their regular form and direction, point to a continual westerly current or set running over them, thus causing them to assume the form of sand dunes, such as are generally found on a sandy plain over which the sea-breeze, or any other wind from one direction, is blowing almost continuously: and the current is doubtless always there, as I have noticed in many works on the subject, and current charts, that there is a northerly current up the centre of the Bay; which probably, running up the Swatch of No Ground divides itself on striking the sand banks: the one stream running eastward towards the Arracan Coast, and the other stream running away west towards Point Palmyras and False Point. Were there not such a current up the Swatch of No Ground, the silt would soon fill this deep gap up, and level it off: as all the other ground east and west of it has been long since levelled by the never-ceasing supplies of sand and clay brought down by the river streams.

Probably now that observations are recorded at the light ships of the force and direction of the tidal streams all the

year round, more light will in time be thrown on this interesting question:—the peculiar and regular form of the sands east and west of this deep gut of clear salt water.* The mud off this, and all the sands and channels to the westward, is found mixed with sparkling sand like steel filings.

The main body of the tide, both flood and ebb, seems to set more to the westward than to the eastward, excepting in hard westerly gales in April and May; but even then it is rarely the pilot vessels are driven off the station on account of an easterly set, unless the sea is heavy and the wind so high that little sail can be carried, when there may be a drift of from 1 to 2 knots only. *(See below.)*

When the winds are strong and much sea on, vessels under sail should avoid falling to leeward of the tail of Saugor Sand, as there is no outset to help them to windward, but only apparently dead water.

This deep water track through the Eastern Channel gives 32 feet, one-fourth of a mile east of the Upper Saugor Sand Buoy; 39 feet, a half of a mile west of the Centre Saugor Sand Buoy; 50 feet, 1¼ miles west of the Lower Saugor Sand Buoy; and 63 feet, 1 mile east of Eastern Channel Light Vessel.

The channel is marked on its western side by the Lower Reef Buoy, the Upper Reef Buoy, and the Spit Buoy (234),—all laid on the eastern edge of the Eastern Sea Reef; and by the Bell Buoy, the Lower Middle Ground Buoy (194), and the Lower Gasper Light Station Buoy (172),—all laid on the eastern edge of the Eastern Channel

* Since the above was penned, through the courtesy of Lieut. A. W. Stiffe, I. N., Port Officer, Calcutta, I have had access to the Tidal Registers kept at the Hooghly Light Vessels stationed at the Sandheads, have carefully worked out three spring tides of each semi-lunation for the year 1880, and have added the results in the shape of a table showing the sea-set at the Sandheads (379): which I believe goes far to bear me out in my above stated theory of the continuous westerly set of the sea and its action on the characteristics of these sand banks off the mouth of the Hooghly.

Middle Ground. Its eastern side is marked by the Lower, Centre, and Upper Saugor Sand Buoys,—all laid on the steep western edge of Saugor Sand. Its north end is defined by the Lower Gasper Light; its centre by the Intermediate Light Vessel and its Station Buoy (244); and its south end is defined by the Eastern Channel Light.

It is high water at the Eastern Channel Light Station on full and change days at 8h. 54m., with a rise of tide in the springs of 11 feet, and in the neaps of 9 feet, and where the first quarter of the flood sets from W. to N.W., second and third quarters from N.W. to N., and the last quarter from N. to E.N.E. The first quarter ebb sets from S.F. to south, second and third quarters from south to S.W., and last quarter, S.W. to W.;* the main body of water, as above stated, setting to the westward through the best part of the year: and not, as most directories indicate, as much to the eastward as to the westward. The current of both flood and ebb runs for about one hour after the tide has reached high and low water, and on the springs the tide will run sometimes 3 knots at the Eastern Channel Light and 2 in the neaps if the horizontal parallax is great, and on the springs there is seldom* any slack water, as the tide sets right 'round the compass. And these remarks about the tides and set will serve for all parts of the Sandheads below the latitude of the Lower Gasper Light Vessel; of course the tides run stronger further up into the estuary of the river, than they do to the southward at the Sandheads.

Standing to the westward in the Eastern Channel, the water shoals more gradually than in the South and Western

* According to the tidal curves worked out from the registers kept during the year 1880, by the outer Light Vessels, we find the set of the tide at the Eastern Channel Light has a great deal of northing and southing, the curves bulging out to east or west, but very little, whilst the curves of both the Mutlah River and Pilot's Ridge Light Vessels show the revolving motion of the tides, making a pretty regular loop to each tidal curve. See Table of Sea-set (378), &c.

Channels. There is always smoother water on the eastern side in deep water than on the western side of these channels, where the water shoals, so that, in standing to the westward, the swell will indicate shoal water on the Reef, and standing to the eastward, the comparative smoothness of the sea should warn the pilot to feel the bottom with his lead for the soft but tenacious clay found near the edge of Saugor Sand, as his sure mark for going round. Sometimes the lead sticks so firmly in this tenacious clay that the line parts to the strain of trying to pull it out, as noticed above.

357. **The 7-Fathom Curve.** The courses and distances on the 7-fathom curve from the tail of the Western Brace (331) to the tail of the Roymutlah Sand, is:—From tail of Western Brace to tail of Western Sea Reef, S.E. by E., 16½ miles. From tail of Western Sea Reef to tail of Eastern Sea Reef, E. ¼ N., 15 miles. From tail of Eastern Sea Reef to tail of Saugor Sand, E. ½ N., 14 miles. From tail of Saugor Sand to tail of Subtermooky or Lighthouse Sand, E. by N. ½ N., 10 miles. From the tail of Subtermooky or Lighthouse Sand to the tail of Bulcherry Sand, E. by N. ¼ N., 7 miles. From the tail of Bulcherry Sand to the tail of Roymutlah Sand, N.E. ¾ E., 7 miles. From the westward of the tail of the Western Sea Reef, the curve of 10 fathoms is very little influenced by any of the tails of the sands, going right across in a line E. ¾ N., with slight bends abreast them and the channels between them.

358. **Chart of the Sandheads.** The best chart for navigating the Sandheads with is No. 115. A chart entitled "False Point to the Mutlah River, and showing the approaches to the Sandheads," compiled by R. C. Carrington, Esq., F.R.A.S., Marine Survey Department, Calcutta, for the year 1878; and from which I have taken my principal data.

It will greatly help the navigator, especially on a dirty

night when his light burns dim, if he take the chart, and with a camel's hairbrush and paints of the seven prismatic colors, run curves of equal soundings across and across, to seaward of the tails, round the sands and up the channels—red for 40, orange for 30, &c., say, in 40, 30, 20, 10, 7, 5, and 3 fathoms—it will then be seen how close to the western edges of the sands the 7-fathom curve cuts, and that, if well inside their tails, it is dangerously close to their western edge. Also how short a distance (2 or 3 miles), separates the 40, 30, and 20-fathom curves at the head of the Swatch of No Ground; and how, from that locality, on the eastern side of the chart, the curves gradually open out from each other, till abreast and due south of the Eastern Channel Light Vessel.

Shows there is a space of 3¾ miles between 30 and 20 fathoms, of 4¼ miles between 20 and 10 fathoms and a little further to the westward off the tail end of the Eastern Sea Reef, of 4 miles between 10 and 7 fathoms: also, that due south of the tail of the Western Sea Reef and steering north, there is a space of 9 miles between 30 and 20 fathoms, of only 2¾ miles between 20 and 10 fathoms, and of 3½ miles between the 10 and 7-fathom curves: also, that the space between the 30 and 20-fathom curves opens out wide across the head of the Pilot's Ridge when approaching the light vessel from the eastward or south-eastward.

It shows you that 28 fathoms, 26 miles due east of False Point Lighthouse, is in the longitude of the eastern edge of Palmyras Reef, and that 10 fathoms is very dangerously close both off False Point and Point Palmyras shoals; that you deepen your water when running N.E. from 13 to 16 or 17 fathoms off the latter, but shoal on the same course from anywhere inside 50 fathoms when off the former Point.

And it shows that False Bay is a proper place to beach a foundering vessel in, as the shore can be approached closer than at any other part of the whole coast line. Also that the Pilot's Ridge, with its extensive plateau of

clear sand, shells, and stones, the out-scouring from the Kunka, Kannaka or Dhumrah River, is a splendid mark and guide to the Pilot Station, when in doubt about the position of the vessel and in dirty weather. And many other obvious advantages are secured by this plan of coloured curve lines of equal soundings.

359. **The Sub-marine Sand Dunes:** In a work on Geology, by T. W. Jenkyn, in Cassell's Popular Educator, we read:—"It is obvious that, when the wind from the sea drives the sand before it, the sand will be drifted onward until it meet with something to obstruct it, such as stones, bushes, or grass. If there accumulates in little heaps, which, in their turn, offer greater resistance to the wind and check the drifted sands, which cause the previous heaps gradually to rise into mounds or hills of considerable elevation. It seems that when these dunes have reached a certain height, the wind has no power to increase their elevation, but drives the sand over their summits, which settles down to form a new ridge behind the other. It is in this way that the wind urges forward several ridges or dunes upon the land. It takes place thus: on the windward side of the hillock, the grains of sand are forced up, from which they are swept off as they arise, and fall by their own weight on the opposite slope; while this mass is invading the land, fresh materials are constantly brought from the sea by the winds. The inhabitants of dune districts have found that a species of plant called arundo archaria thrives well in these sands, and prevents the winds from drifting them. Every hillock, which becomes thus fixed, will form an effectual barrier against the incursion of fresh sand from the sea."

Now, in the above account of the formation of sand dunes by the action of the winds, we have evidently a clear explanation of the causes which produce those long parallel ridges of hard sand running out across the almost constant westerly set of the salt sea current: and which current under favorably-producing causes runs at the

rate of 5 knots :* for we have only to substitute this set or current for the wind; and on account of the greater buoyancy of sandy particles in water than in air, we can easily imagine how more readily they are taken up by the eddying tidal current, kept in motion by the ground swell inside the 10-fathom line of soundings, transported and deposited in suitable situations as sub-marine sand dunes; not forgetting the disturbing effect of water of different specific gravity and temperature, running out of the rivers as it meets the westerly current setting across them: always, as I believe, pouring forth with greater or less rapidity from the Swatch of No Ground, the goal of the current which has been so often noticed as setting up the western coast of the Bay (see 360). And possibly, it is due to the influence of the southerly currents of fresh river water, that these sand dunes are prevented from working their way to the westward: the steady outpour acting as stop-blocks similar to the stones and bushes which have the same effect on sand dunes of the dry land.

Right through the length and breadth of the river, all the sandy particles work their way upwards to the shallowest parts, whilst the deep parts always consist of "soft bottom." The most part of the clay is deposited close into the mouth of the river; thrown down by the admixture of salt with the river water.

[We learnt a few years ago from a renowned medical gentleman of Calcutta, that the reason the water in the pipes was so turbid, was because during the freshets the river water was so very pure, it was hard to take the clay from it, even after it had lain in the settling tanks for many days and had passed through several filters. But

* Since the above was written, I find from Tidal Registers kept on board the Light Vessels, the mean daily set of the waters past the different stations is for the year 1880 as follows:—Mutlah Light Station W. ½ S 12·1 miles. Eastern Channel Station, S. W. by W., ¾ W., 6 miles. And, for the six months the light was in position, Pilot's Ridge Light Station, N. W. ½ W., ⅜ mile. *See* Table of Sea-set (379).

the addition of a little alum is sufficient, and, like magic, the clayey particles, instead of being repelled from each other until the water assumes one homogeneous hue, are attracted or drawn towards each other, in fleeces or like cumulus cloud tufts, with clearer water between them, and they gradually subside and sink to the bottom.]

But the main body of the ebb-tides of the upper parts of the estuary seem to set away towards Balasore Roads, an extensive and almost circular shallow bason 40 miles in diameter (see 332), which seems to be the great settling tank for the Hooghly deposit, and also the evaporating pool for it.* There seems to be a set of the waters from the rivers about Point Palmyras towards the tail of the Western Sea Reef, and which probably acts in a similar manner to the current, which, I suppose, runs up the Swatch of No Ground, and which tends to keep the tail of this sand so abrupt and steep to, as it is found to be. The very shape and character of the Pilot's Ridge seems to indicate that it is so.

360. **The Swatch of No Ground** is a remarkable deep gut, some 6 or 7 miles broad, and said to exceed 2,000 fathoms in depth in some parts, though this is doubtful, as we read in Mr. Blanford's Rudiments of Physical Geography in a foot note:—"1,785 fathoms was the greatest depth indicated by the dynamometer in laying the telegraph cable between Penang and Madras."

It runs up in a straight line N.E. by N. or N.E., and seems to be kept open by the current, which Mr. Blanford,

* I find, as elsewhere noticed, that there is, in May-June at least, one and-a-half grain of salt more in one ounce of sea-water, from half ebb to the next half flood, than there is at high water, at the Eastern Channel Light Station: or 9½ grains to the ounce at high water and 11 grains after half ebb. Of this fact the engineers of our Steam Tugs and Coasting Steamers seem to be aware.

And, with regard to the difference of surface sea temperature, I have seen it, at the same locality and date, rise from 88° on the flood to over 91° at low water after a calm hot day, or 2° nearly above the air temperature.

in the above little book, tells us, "as long as the south-west winds blow on the coast of India (which is during eight months of the year) runs up the coast, from south to north." And by examining Lieutenant Ferguson's Wind and Current Charts, this surface current is indicated in April in 19° N. 88° E., going N.E. 45 miles in the day. In May we find an arrow indicating a current in 21° N., 89° E. to N.E. by N., 50 miles; and in 21° N., 87° E., to the N.N.E., 14 miles. In June, in 18° 30′ N., 88° E., to the N.N.E., 45 miles in the day; and in 21° N., 90° 30′ E., to the N.N.E., 17 miles. Also, we see arrows showing the current turning eastwards and down along the Arracan Coast, towards the eastward of the Andamans. July shows these currents and how much more they turn off down this coast, down as far as 10° N. August the same, and also that the turning has extended much further south and also at the head of the Bay. September shows, in 19° N., 90° E., a current S.E., 35 miles in the day.

But the westerly set at the Sandheads proves there is also a current (either surface or deep sea) pouring out of the Swatch; and even at the beginning of February of this year 1881, I took careful observations, and found that for two days the tides, flood and ebb, showed this westward tendency of the waters of the head of the Bay at the Sandheads, although the winds were light westerly.

Mr. Blanford says of this Swatch:—"It is not improbable, though it cannot be considered certain at present, that the great channel like depression in the bottom of the Bay of Bengal, mentioned above as 'the Swatch,' is swept free from sediment and kept open by the currents, that carry back to the south the water that has been brought to the north of the Bay during flood tide." *

But, with all deference to that gentleman's theory, is it not rather the sediment is kept out of the swatch by

* Rudiments of Physical Geography for India.

the current which strikes in here after it leaves the Indian Coast off False Point? I think it is evidently the original depth of all the Bay before the silt from the rivers encroached down so far as it has done, and that the current running up its length turns off mostly towards the Arracan Coast; but partly also westwards over the tails of all the remarkably well-formed sub-marine sand dunes, alone to be found to the westward of its head.

And here I may as well quote from Findley's Sailing Directory, Lieut. J. A. Heathcote's remarks on the currents of the Bay of Bengal, during the S.W. monsoon, as they will, besides being generally useful to shipmasters, throw some light on the theory here set forth concerning this curious gut of deep water called the Swatch of No Ground; and, as I believe, go far to prove the correctness of my argument:—"On the Coast of Coromandel, a northerly set prevails within 30 miles of the shore as far north as the parallel of 15°; outside these limits it turns to the north-eastward. North of the parallel of 15°, it takes the direction of the land as far as Gardeware Point, and thence treads in an easterly, and afterwards a north-easterly, direction across the Bay. From False Point nearly to Vizagapatam, we have a strong S.E. current of three-quarters to one and-a-half miles per hour within 30 miles of the coast; but farther to the eastward, it gradually succumbs to the influence of the wind, and joins the general set, first in a north-easterly, and then in an easterly, direction across the Bay."

"*Aracan.*—On approaching the coast of Aracan, the current becomes more northerly, and finally is governed by the form of the land, and runs strongly to the north, north-westward. It thus becomes a very dangerous current for vessels making Akyab during the S.W. monsoon. * * * 'In some of the works on this subject, all mention of this subject is omitted, it is represented as running in a contrary direction; it is therefore the more necessary to call attention to it, as either the want of information

on the one hand, or the existence of erroneous information on the other, may lead to injury to the greatly increasing trade of Akyab.'"

"This northerly current along the Aracan Coast may, probably, have a very intimate connection with the southerly current on the coast of Ganjam. They may both belong to the same system of circulation, the Aracan current finding its way to the westward along the sea-face of the Sunderbunds, and becoming the southerly current at False Point, and being again thrown on the coast of Aracan, as before described. But if this be the case, any positive trace of the westerly movement is not to be discerned, or at least is most difficult to recognise in the peculiar rotatory tides which are found to seaward of the Sunderbunds. These tides set at different periods of each tide towards every point of the compass. The flood begins at W.; at the first quarter it flows N.N.W., at half flood it is about N., the last quarter being to E.N.E. The ebb begins at E., half ebb runs about S., and the last quarter ebb W.S.W., thus forming a complete rotation. But, although these rotatory tides go far to hide the current itself, its effects, while working its way to the westward, are observable in the configuration of the sandbanks off the mouths of the Ganges. The current would here exert its greatest force, and these banks are curved to the westward in a remarkable manner, their very form proving that they are under an influence stronger than that which bends the banks off the mouth of the Hooghly into their south, south-easterly position: the latter being due to the S.W. monsoon itself, while the former is the effect of the current of the same monsoon concentrated, as it were in a funnel, by the shores of Aracan. That the position of the banks off the mouths of the Ganges is not caused by the N.E. monsoon, admits of but little doubt; for this portion of the sea is peculiarly sheltered from the N.E. winds, and they cannot be supposed to exert a force sufficient to effect the position of these sandbanks, as, were it so, the effects of

this force would be apparent in a much greater degree to the westward; and the sands at the entrance to the Hooghly would lie in a south-westerly direction instead of their present south-easterly one."

"*The S.E. current.*—A strong current to the south-eastward, at the rate of $\frac{3}{4}$ to $1\frac{3}{4}$ miles per hour, begins about Lat. 18° and Long. 90°, flows down towards Preparis Island, and then turns more easterly into the Gulf of Martaban. There is no doubt an accumulation of waters in the N.E. portion of the Bay, caused by the steady blowing of the S.W. monsoon, across the whole breadth of the sea; and this current seems to be the result of these waters attempting to find an exit. It may be of important advantage to ships from Calcutta bound to ports to the eastward, for it will materially help them in getting to the southward against the wind. From its eastern edge the currents turn off to the north-eastward, until near the coast of Pegu, they become governed by the form of the land, and take a course to the N.N.W., joining those on the coast of Aracan."

We also read in another part of Findley's Sailing Directory:—"In the N.E. monsoon, the coast of Aracan, as well as all the eastern side of the Bay of Bengal, should have a good berth."

"If the Bay is reached about the first days of February, there is no need to lose time in running to the eastward, for the easterly and S.E. winds begin to be felt on the coast of Ceylon and to the north of the Basses. The currents besides run up the Coromandel Coast. In the strength of the N.E. monsoon, it is advisable, on the other hand, to keep off the land and tack in the middle of the Bay, or on its east side. Towards the end of September, the eastern side of the Bay should be chosen to approach the bank to windward of the (Eastern Channel) light ship. The current sets to the westward, with incredible rapidity, towards the end of September and in October; and if the land is made to leeward (westward), there will be great difficulty in making the Saugor Channels."

Should the ship in September or October unfortunately make the land to the southward of False Point through any contrarieties, there is great risk of losing the voyage, &c., &c. "The southerly current attains its maximum rate in November and December; indeed, it will be found to run to southward and south-eastward in the S.W. monsoon." "It is therefore more advantageous, even at the end of December, when this current is losing its strength, to beat up in the middle of the Bay of Bengal, or on its east side, rather than in the western part, in order to steer directly for the Eastern Sea Reef, or the tail of the Saugor Bank. On the western side of the Bay at this season, the currents frequently attain a velocity of 3 miles an hour." "During all the N.E. monsoon, sailing from the Coromandel Coast for Bengal, the eastern side (of the Bay) should be made for, then bear up to the northward along that side, or else in the middle of the Bay, which is usually preferable, for here you will avoid the southerly currents which are frequent on the east coast at this time." And at page 186 of the same work we read:—"There are many anomalies in the currents at this season; for while they run with great strength to the N.E. near the coast (Coromandel and Ganjam), they are feeble in the offing, and when they run to the N.E. in the open sea, they are inappreciable near the land."

And here we may as well consider what Captain Miller wrote to the Nautical Magazine in 1843, as it also has some bearing on these currents of the Bay and their effect in keeping open the Swatch of No Ground, and may serve shipmasters bound to and from Calcutta. I have taken the extract from Rosser's "Short Notes on the Winds and Currents of the Bay of Bengal:"

"*From 15th January to 31st May.*—Going north, or up the Bay, take the western side; coming south or out of the Bay, take the eastern side.

"*In June, July, and August.*—Going north, keep in the middle of the Bay; coming south, take the eastern side, even east of the Andamans.

"*In September, October, and November.*—Going north, take the eastern side; coming south, take the western side.

"*In December and to 15th January.*—Going either north or south, keep the middle of the Bay, and make short tacks."

Perhaps the strong current up this Swatch may account for the loss of fine ships on the sands at its head in the S.W. monsoon, their commanders not thinking they had overrun their distance: and having, in the dirty weather, to trust to their dead reckoning; and once in the Swatch the lead is of no use. Also it may account for vessels wrecked in the N.E. winds of October, by the effect of this current setting them to the N.W. on the western edge of the Swatch.

The head of the Swatch is very steep to, the depths shoaling, when standing to the northward, from 100 to 7 and 5 fathoms in a few miles; it is, therefore, both on this account and also on account of this N.E. sea current setting on to these eastern sandbanks, such as the Argo Flat, on which the ship "Lady Belhaven" was lost in the S.W. monsoon of 1879, that great care should be observed hereabouts.

Its length makes an angle with the general trend of the tails of the sands to the westward of it, of about three points, and, with those to the eastward of it, of about twelve points; so that a ship shoaling on the Argo Flat or on the Roymutlah sand would find herself partly embayed; and, if my theory is right, as regards the current up the Swatch; without any or very little ebb current to help her off with during a southerly gale.

Its N.E. extremity is in 21° 24′ N., 88° 35′ E., and its N.W. extremity or edge is in 21° 13¼′ N., 88° 13′ E. A line drawn through these two positions, or S.W. by W., 22 miles, from the first position, may be called the head of the Swatch, along which and between it and the tails of the sands to the N.W. much care in heaving the lead must be used, as the soundings alter rapidly.

As the light vessels stationed off the Mutlah River, the Eastern Channel, and Pilot's Ridge, are now registering the strength and direction of the currents running past them,* there will doubtless be valuable information gained on the subject: and I have no doubt proof will be forthcoming, which will show that my surmises are correct and that there is a constant cyclonical rotation of the waters contained between the Swatch, round to the northward and westward, to the coast of Balasore and Point Palmyras, or even down to False Point.

I have struck soundings in 65 fathoms on the eastern edge of the Swatch and had green mud and sand on the lead: but the Pilot's Ridge is the only spot in all the Bay where the nature of the bottom is clean soundings and free from mud. See Pilot's Ridge (328).

I think, this Swatch of No Ground with its insetting current, and terminating as it does in a concave bend of the line crossing the tails of all the sands, being to leeward of, and in such close proximity to, the entrances to the Mutlah River, is another very conclusive argument against making that river a port for sailing vessels to trade to.

361. **The Pilot Station.**—The station for Pilot Vessels is now, within a distance of from 7 to 10 miles, in the S.W. monsoon, south to south-west of the Eastern Channel Light Vessel: and within a mile or two West to N.W. of that Light Vessel in the N.E. monsoon: at which time they will be found at anchor on the ebb tide or during light winds, when they are liable to drift off the station.

Unless some accident has happened to one, there are always two vessels on the station doing pilotage duty—brigs of between 200 and 300 tons burden, with double topsail

* This has been done, and since the above was penned, the results have been worked out (for a limited period only), and which shows that there is, throughout the year, an average daily flow of the water as follows:—Mutlah Light, W. ½ S., 12·1 miles. Eastern Channel, S.W. by W. ¾ W., 6 miles. Pilot's Ridge (for six months), N.W. ½ W., ⅔ mile. See 279, &c.

yards and painted black with white band and imitation ports. The cruiser or supply brig is generally a mile or two further to the southward than the taking out brig is, and flies, at the main, a large red flag on a ship in want of a pilot being sighted: and she also flies the British blue ensign at the peak. The buoy or receiving brig flies a white flag at the fore on sighting an outward-bound vessel and also a blue ensign at the peak.

The pilots are in four grades; the twelve senior pilots are called Branch Pilots, and have the privilege of taking vessels from the Sandheads of over 1,700 tons. The next thirty are called Senior Masters, who take all vessels of 1,700 to over 1,350 tons. The Junior Masters take all vessels of 1,350 tons to over 800 tons; and the Mate Pilots all of 800 tons and below it: hence sometimes a ship may get her pilot sooner, if she, on approaching within signal distance of the cruiser, hoisted her gross tonnage if a steamer, and registered tonnage if a sailing vessel, to enable the Commander of the Brig to warn the right officer of the turn.

In supplying vessels with pilots in the S.W. monsoon, the brigs invariably lay to on the starboard tack (the holding-on tack for vessels close hauled) so as to head the sea whilst hoisting out the heavy boats; therefore, should the circumstances of wind direction, swell, and time of tide, suggest it, preparations can likewise be made in time by the incoming ship to lay to on the same tack. The boats are sluggish in the water and manned by natives of India; therefore, if it is blowing fresh, the foresail of a ship should, in all cases, be hauled up to give the boat a better chance to catch up with the ship: often much valuable time to both ship and pilot vessel is lost through the ship's way not being sufficiently deadened on laying to, with perhaps, staysails, as well as foresail set.

On no account show a bright light at the peak or at the ensign staff, when coming in for a pilot on a fine night, as that is the exclusive signal of a vessel wishing to disembark her pilot; but show only the authorised night signals for a pilot.

On making the Pilot Station during easterly winds, always be prepared to find the brigs at anchor: for the westerly set runs so strong with these winds that they must anchor to prevent being driven off the station; so ships should have a boat ready to lower to send for a pilot in the event of the proper pilot vessel signalling to that effect: as very often having a long scope of chain to heave in, she would likely not be underweigh in time, and the pilot brigs never send their boat away when the current is strong until they have tripped anchor. Whereas, had the ship a boat ready and could so manage it as to drop her ahead of the brig flying the red flag, the master would, in these cases, obtain his pilot without having to anchor. So that, coming in and sighting a pilot brig at anchor to the northward during easterly winds, a master should brace sharp up on the starboard tack and haul his wind, so as, if possible, to cross her bows and be in a position to send a boat for a pilot.

The signals used by the Pilot Vessels and other Government of India vessels, when communicating with each other, is similar to that used by the Trinity Board around the British Coasts; *viz.*, the International Code Flags with a geometrical shape—a cone, an inverted cone, or a drum being in each hoist; so that vessels cannot be misled; for when either of these shapes or any strange flags are seen amongst the flags of the hoist, commanders of vessels must understand, it is the Pilots' Code of Signals which is being used. All directions as to anchoring or manœuvering vessels will be made in the International Code.

On making the Pilot Station in the S.W. monsoon and no brigs are to be found, keep working to windward: and be careful not to get to leeward of a line S.E. of the Eastern Channel Light Vessel, as there is a dead water under the lee of Saugor Sand, where there is no outset to assist you to windward. By keeping the above light to bear between N. and N.E., no trouble will be experienced in keeping on the station even if obliged to reduce sail, except in heavy

westerly gales. A S.E. gale is the most awkward wind to be caught at the Sandheads in, as the set is then always strong to the westward: and unless (having your pilot on board) you have a good weatherly position, your ship cannot fetch into the channel leading to Saugor.

The pilot vessels supply vessels with pilots by night as well as by day if the weather is not too boisterous for boating; but caution is much needed when rounding to to leeward of a pilot vessel by night, as it is hard to judge distance, and if a ship rounds to too close the sea between the two vessels is likely to swamp the boat: so it is much the best plan to keep well off to leeward and allow the pilot brig to run down with her boat at leisure. The vessel desiring a pilot should burn the usual signal flare-up or blue light, when the pilot vessel will attract her attention in reply by burning frequent flare-ups or maroons, and if the Taking-out Pilot Vessel should be in company, she will, on seeing the supplying brig burning her frequent flares, discontinue showing hers, so as not to mislead the incoming vessel. But, since the new rules have come into force, directing pilot vessels off the Hooghly to carry side lights, the all-round mast-head light is an efficient signal of being prepared to send a pilot. By night, the pilot vessels both conform to the latest International Rules of the Road at sea,—that is, "when engaged on her station on pilotage duty;" or, in other words, when she is hove to with her boat out, in the act of getting it out; or, when waiting for a boat which is away; and, consequently, impotent to get promptly out of the way of other vessels, or to manœuvre, as the Rules require that vessels carrying coloured side-lights should do: they show under these circumstances only a bright all-round light at the main-royal-masthead: and likewise, to indicate how they are heading, they show a bright light astern over the taffrail (but which light from its position right aft, and almost directly beneath the bright light at the main-royal-masthead, is not of much use in indicating which way the vessel's head is). And, "when not engaged

on her station on pilotage duty," or in other words, when not competent to manœuvre as the Rules require vessels carrying coloured side-lights should do; or when on a dirty night it is not possible to hoist a boat out with safety to the crew, or when there are no pilots on board, the pilot vessels show the same coloured side-lights as other vessels; but when thus prepared to obey the Rules, the bright mast-head light is hauled down and the taffrail light taken in.

Both night and day, to attract attention, the pilot vessels often fire a signal gun; and, by night, to show their position and what they are doing, burn a blue light. The 15 minutes' flare-up* will always indicate a pilot vessel, either when at anchor or underweigh.

When making the station in the N.E. monsoon, and it is high water, it is always much the best plan to drop an anchor than try to work over a spring ebb tide, as the outset of a tide always exceeds the inset; and, besides, the pilot vessel would not likely keep underweigh on an ebb tide; in such cases a kedge shackled on to the bower chain is very useful: and then, there is no fear of parting the chain when heaving up and there is the usual ground swell. And if a vessel has unfortunately got to leeward during easterly winds or in the N.E. monsoon, the small anchor will be found the most useful for working back again in tides works.

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* These flares are called maroons; they are made of old junk opened out, tarred in the centre, and the loose yarns all marled up with spunyarn, making a huge torch of six inches in thickness and about two fathoms long, and which, when once lighted, lasts nearly all night; it is kept smouldering in an old copper pot called a dekchee, and covered over by damped gunny bag and a tarpaulin. When being burnt, a boarding pike is stuck into it, and it is thrust up into the breeze to leeward, and at once it flares up one or two feet, showing a good and efficient signal fire or flare visible for six or seven miles around, and I would recommend it far above the dangerous, dirty, and inefficient turpentine box arrangement, as it can be kept ready in all weathers and costs little: of course, such a large one need not be wanted by a ship making a signal for a pilot; a maroon of three or four inches in thickness, and three or four feet long, would be large enough for the short time it was wanted.

Be careful to keep the lead going when approaching the tails of the sands on a spring flood tide.

In case of having to work tides works to get to the eastward, remember that the tides will be against the ship from first quarter ebb to first quarter flood, and if it should so happen that the ship gets to leeward in light westerly winds, the tides will be against her, in on the tails of the sands, from half flood to first quarter ebb, so that she should either anchor or stand to the southward on the flood: however, there will not be the same difficulty in getting to the westward as to the eastward, on account of the tendency of all the waters of the littoral to set to the W.S.W.

Vessels often call at the Pilot Station and anchor, waiting for orders; but, excepting in the months of December and January, it is far from a safe anchorage, as there is often a considerable ground swell; and as the tides run round the compass so as to cause a vessel to be continually dragging her chain round her anchor, and so of fouling it; and mooring with two anchors being out of the question, as the chain twists up at the rate of two turns a day; and besides, as there is no means of communication with the shore, 35 miles off, excepting by the chance of a tug steamer or some incoming vessel: it is therefore an undesirable anchorage, seeing there is such a good one at Saugor, where there is electric telegraphic communication with Calcutta:* and as the saving of pilotage in and out to Saugor is a trifle compared to the loss of an anchor and chain, ships should not be allowed to await orders here except, as aforesaid, in the two best months of the year.

Steam tugs are invariably to be had at the Sandheads, except in bad weather, in the S.W. monsoon: when, the heavy swell running with the vessel towing in, would

* On the 15th October, 1874, the "Grand Duchess," at anchor in the Eastern Channel, was caught in a cyclone, parted her anchors, and was lost with all hands, on the Eastern Sea Reef; the set running to the westward too strong to admit of her either getting into Saugor anchorage, or of running to sea.

render the hawsers more likely to part, and therefore it is best for the vessel to run in herself. The prices for towing vary as the demand; ships generally paying from 800 to 1,500 rupees, from either Saugor, or sea, to Calcutta. In the N.E. monsoon, when there is not much doing, the tugs often take a turn seeking, some 30 or 40 miles round outside the Pilot Station. The steamers supply one hawser on the port side, and the ship is expected to give the other on the starboard side, unless special arrangements are made for the steamer's spare hawser, and for which an extra charge is made. So as to be ready in case of an accident, or in an emergency, the ship should have her hawser so belayed as to be able to slack away: the steamer attending to and working her (port) hawser as required.

A medical officer is resident on board one or other of the pilot brigs for the convenience of the servants of the Government serving afloat only; but who will not refuse to attend upon private patients in case of need, when his services are requested by any vessel signalling, and it is convenient for the pilot vessel to leave her other duties to bring and wait for him.

Masters of vessels anchoring at the Sandheads to wait orders, should anchor somewhere to the N.E. of the Eastern Channel Light, out of the track of vessels passing to and from the pilot vessels, and all vessels anchoring should put the anchor light at the starboard foreyard arm (as is the custom of the port).

THE WEATHER AT THE SANDHEADS.

362. **The Weather at the Sandheads.**—The seasons at the Sandheads are made up by dividing the twelve months into three distinct states of the weather. October, November, December, and January constituting the north-east, or, as more properly called by Mr. Blanford in his Indian Meteorologist's Vade Mecum, the winter monsoon. February, March, April, and May, the dry and hot season of Bengal. And June, July, August, and September, the rainy season; and combined with the four preceding hot and dry months, called the summer monsoon, the winds being at the Sandheads more or less southerly during these latter eight months.

Captain N. Heckford's very useful Sailing Directions and Coasting Guide tells us of the weather hereabouts:—

"As sudden changes are liable in the months of April and May, September and October, and sometimes November, a careful observance of the weather in these months is particularly necessary.

"Sudden N.W. squalls (*see* 368 *in this book*) are very prevalent in the head of the Bay in the latter part of February, more especially in March and the early part of April; of these beware. And if bound to the northward, make all snug in time, or the chances are, you will lose both sails and spars.

"During the S. W. monsoon, if lightning is seen from south to south-west, or west, it is a precurser of worse weather.

"Squalls that arch, or that are preceded by rain, should not be trifled with, more especially during the strength of the S.W. monsoon."

And here I would remark that in considering the above

old sailor's comments on the arched squalls of the the S.W. monsoon, and about

> "When the rain comes before the wind,
> Topsail halliards you should mind,"

we would do well to go along with Mr. Blanford and Mr. Eliot in their explanation of our Nor-westers given at 368; and, possibly, their causes may be found to be nearly the same;—a subversion of the meteorological conditions, and the downrush of a mass of air from some upper stratum of the atmosphere, to replace that which has risen up in the storm cloud with "a burst," in obedience to the disturbed state of its relative temperature, humidity or vapour tension and the resulting disturbed relative atmospheric pressure:— a downrush from a mass of air moving in some other direction* than from that from which the surface wind was blowing previous to the squall. But, *see* June, 372.

In discussing the weather at the Sandheads, I have thought it best to do so month by month, and begin with the autumnal transition period.

363. In **October** the baric pressure, which up to the end of September preponderated over the sea, has undergone a great and sudden change, and the pressure is now exalted over the land (Bengal), whilst the centre of the Bay has become the seat of low pressure with high pressure also to the southward near the equator. So that with the very slight baric difference between it and the surrounding shores of the Bay, there is a tendency of the winds to circulate round it cyclonically: assisted as it is by the young N.E. or winter monsoon, just beginning to wage war with the now almost exhausted S.W. or summer monsoon, which is still in full force at the south end of the Bay, and striving

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* And, as I believe, from long-observed cloud-motion of those higher strata, generally from some direction more to the right of the prevailing surface wind, and because, a vessel caught in an arched squall from any quarter when on the starboard tack generally comes up in it, and one on the port tack breaks off and is caught aback in it.

to drive it out of the field; or, as the late Captain Maury says in his Physical Geography of the Sea: "In October the bi-annual conflict begins in the north of the Bay face to face between the two monsoon winds, with a medial line of low baric pressure between them and towards which they both blow (as they work down) forming an uprising current."

And now let us go to Mr. Eliot for instruction:*—

"Without attempting to give any general explanation of the origin of cyclones which, with suitable modifications, dependent on local and temporal conditions, will apply to all such storms, I shall now endeavour to discover if there were any assignable adequate causes at work during the first week of October for the formation of this particular cyclone. In doing so, I hope to trace a sufficient connection between the actual phenomena and the forces and causes in operation during this period. But before attempting this, I shall test briefly the various theories put forward for cyclonic generation by the phenomena of the present cyclone. First, the verticose or spiral motion of the atmosphere converging towards the centre is indicated too plainly in the various charts to permit the assumption of the circular theory as held by Reid, Piddington, and others. Also, there is no evidence of any distribution of the winds during the period preceding the cyclone, which can in any way be considered as centripetal. The fact of the approximate approach to equilibrium of pressure over the whole of the Bay and Northern India on the 2nd and 3rd of the month, is another argument against the adoption of Espy's hypothesis or Taylor's modification of it, to explain the formation of this cyclone.

"The hypothesis of parallel winds in opposite directions appears on dynamical grounds to fail to give an adequate cause for the motion of this large mass of air. That which may be more properly termed the cyclone, was a rotatory cylinder of air, forty miles at least in diameter, moving with an average velocity of from thirty to sixty miles per hour, not regularly, but in irregular heavy gusts with intermittent lulls. Before the formation of the cyclone,

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* **Report of the Vizagapatam and Backergunge cyclones of October, 1876, by J. Eliot, Esq., M.A., Meteorological Reporter to the Government of Bengal, page 66.**

the log of the 'Tenasserim' and the wind returns of 'Nancowry' show that there was, on the eastern side of the Bay, a moderate breeze blowing, probably at the rate of from four to nine miles per hour. On the opposite side of the Bay north-easterly winds had only set in a few days before, and were blowing very gently and with an average velocity of from two to four miles. The period was evidently, so far as winds were considered, one of transition, a passage through a state of equilibrium, in which the opposing forces producing the winds are in a state of neutralization and incompetent to give out enormous supplies of energy. There was also undoubtedly in the middle of the Bay variable winds and calms until, as shown by the log of the 'Anne,' a few hours before the commencement of the cyclone. There was a rapid and enormous accumulation of energy in the space of a few hours, and I see no way in which the mere friction of two bodies of air, moving with the slight velocities they are known on this occasion to have possessed upon a central and intervening mass, could have accumulated so rapidly, and so utterly distanced in velocity the motion of the producing masses. I assume that in the hypothesis of the parallel winds, the primary motive-power is the friction, supplemented, as its upholders probably maintain, by the action of the heat given out during the condensation and rainfall which accompanies the cyclone. If this is the theory, it appears to resemble in precision of idea and language the ascription of the motive force of the explosive force of gunpowder to the fall of the hammer or the motion of the finger. It may be a necessary condition and an antecedent to the conversion of potential into actual energy; but it is not there that the believer in the principle of the conservation of energy would endeavour to find the source of the energy. I can only repeat that I believe no amount of friction between masses of air arranged according to the parallel wind hypothesis would suffice to communicate the energy which is absorbed by the moving mass of air forming a cyclone, and which is being very rapidly given out to the surface of the sea over which it passes, and in amount sufficient to raise the largest waves and produce the vast mechanical effects which the sea in a state of disturbance can effect, and which were strikingly shown at Vizagapatam by the scouring away of a depth of fourteen feet of sand from a shoal near the harbour. Another objection is, that the retarding friction between

the vast mass of moving air and the sea must for equal surfaces be very much greater than that between masses of air.

"Parallel opposite winds may be an antecedent and necessary condition, but it is not there the vast transfer and accumulation of energy must be sought.

"The only remaining hypothesis is that of Mr. Blanford, a modified form of which seems to me to explain satisfactorily the formation and phenomena of the present cyclone. The explanation, I may promise, must account for the following antecedent conditions and assign an adequate cause for the following phenomena :—

"*1st.*—It must explain the antecedent condition of opposite winds on the two sides of the Bay, and of the consequent tendency to a cyclonic circulation of the atmosphere round the coast of the Bay some days before the origin of a cyclone.

"*2nd.*—It must explain the barometric depression which accompanies the setting in of the parallel winds, and precedes the formation of the cyclonic vortex of excessive barometric depression.

"*3rd.*—It must explain why the cyclone advances in a northerly direction.

"*4th.*—It must assign an adequate cause for the vast mechanical energy accumulated first as potential energy, and then given out rather after the nature of an explosive agent than that of ordinary matter unchanged in character and constitution and acted on by ordinary finite forces.

"*5th.*—It must also explain the continuous addition of mechanical energy to the moving mass during its passage over the Bay.

"First of all, the fact of opposite winds on different sides of the Bay, together with variable winds and calms in the Mid-Bay, indicates clearly a state of transition, a passage through a condition of unstaple equilibrium. During such a period over the vast area of the Bay of Bengal, with its high temperature, an enormous evaporation is going on, the arrangement of the winds for some days before the cyclone was such as to afford no horizontal outlet to the increasing mass of aqueous vapour held in suspension in the air and forming a separate atmosphere. The regions to the south still continued to pour in supplies of moisture, and the passage northwards, which was its former outlet, was closed. The only action that can take place under these conditions is vertical expansion and

motion. The constitution of aqueous vapour and its relation to the air, and the rate of decrease of temperature with elevation, are such that an equilibrated mass of saturated air without condensation is physically impossible. Hence, under the conditions which preceded the present cyclone, evaporation would go on until the strata at some height above a considerable part of the Bay would become surcharged with vapour. This would occur on the south-east rather than on the north and north-west of the Bay, as in the former there is a double ascension—that due to the influx from the vast evaporating region of the Indian Ocean, as well as that due to evaporation from its own surface. Hence condensation and rainfall would necessarily follow, the amount being greatest in the south-eastern portion of the Bay and extending northwards with the persistence of the conditions. The saturated south-westerly current and the large precipitation, which Mr. Blanford states to be a constant element in the phenomena of cyclones, is thus, in my opinion, not the primary cause of the local barometric depression of the cyclone in the true sense of the word, but a natural and immediate result of the condition of uniformity of pressure round the limits of an almost closed area which precedes the cyclone formation.

"Consequent on the process of condensation is the giving out of an enormous amount of heat, exactly equivalent, either as heat or mechanical energy, to the solar heat or energy absorbed in the process of evaporation. The result of this is to produce a further upward expansion of the strata, in and above which condensation is going on, and of the contained aqueous vapour, to increase the rainfall, and to produce a continuous indraught from the surrounding lower region of the atmosphere to the region over which the 'ascendant courant' has now been established. This indraught takes place in accordance with dynamical principles, partially formulated in Dove's Law of Gyration, and naturally assumes a verticose or spiral character, favoured and accelerated as it is by the previous distribution of winds round the coast. Thus the action of the vast quantity of heat given out during the process of condensation produces an extensive upward motion of the air over a portion of the Bay, and gives the neighbouring air in the lower strata mechanical advantage. This action, a secondary effect of the evaporation and condensation

over the region of evaporation, must be comparable with the producing cause—the vast mechanical energy of the heating power of the sun over the large central area of the Bay of Bengal.

"This explanation seems to me to assign a sufficient, but not an exaggerated, part to the parallel winds on the opposite shores of the Bay, and to explain the presence of the powerful saturated current from the south-west in the southern part of the Bay. Both are evidently, on this explanation, concurrent phenomena which will generally precede the formation of cyclones in the Bay of Bengal.

"It assigns an adequate cause for the comparatively sudden accumulation of energy, and explains the indraught towards the centre and the barometric depression which precèdes the formation of the vortex. It asserts that the action is due primarily to the cause of condensation, which acts not continuously, but at irregular intervals, and is accompanied with a rapid disengagement of vast quantities of heat, which must be accompanied by mechanical action similar in action to the producing cause. It thus assigns a sufficient reason for the uniform character of cyclones, in which violent squalls lasting for some time are followed by lulls. The low barometer at the cyclone centre is due to the following causes: the previous barometric depression; the formation of a comparatively small cylindrical column of ascending vapour and air, due to the peculiar conditions, the upward motion of which is rapid, compared with the slow vertical expansive motion taking place over the large area of evaporation; and finally, to the fact that the pressure of air in motion is always less than the pressure of air at rest under similar conditions of temperature and density.

"It seems to explain also satisfactorily the north-westerly or northerly direction of the advance of cyclones from the place of their origin over the sea, and their generation in the central part of the Bay of Bengal to the west of the Andamans. The southern quadrant, the region of the indraught of the south-westerly saturated current, ought, theoretically, to be the more powerful as the producing causes; rapid condensation and precipitation are there more effective.

"Again, from the evaporating region to the south, a large supply of vapour continues to be poured in during the advance of the cyclone: hence, during the whole of its

progress across the sea, the same causes that were in operation to produce it, continue to maintain it, *viz.*, rapid condensation and precipitation of rain accompanied with the disengagement of vast quantities of heat into the air. The greatest rainfall will, as a rule, be on the south and east quadrants. Also as the cyclone advances, it forms the focus towards which the aqueous vapour generated towards the south tends, and is the natural outlet for it, hence the comparatively fine weather which follows the passage of the cyclone, and the advance of the moisture current northwards. The presence of the Ghats and the slowness of its advance after it reached the coast sufficiently account for the excessive rainfall during the cyclone on the Ganjam Coast. The passage of the cyclone northwards through Chota Nagpore and Behar also explains the introduction of a strong and saturated moisture current into these districts from the Bay, and the subsequent considerable rainfall of the next four or five days."

And now having read Mr. Eliot's masterly elucidation of the phenomena of those great atmospheric convulsions—cyclones, we may as well search Captain Maury's Physical Geography of the Sea, and take therefrom a few notes showing that the stored-away heat of the salt sea of the Bay, and which sea is frequently heated up to 90° Fahrenheit, plays a not unimportant part in giving dynamical force and energy to the currents of both sea and air, as the cyclone's gusty winds and heaving billows progress over its bosom: and on whose dark blue and glassy waters, the sun's rays had been pouring uninterruptedly for days or weeks of stark calm, before nature gave away to the great vertical accumulation of vapour and heated air piled up over the sea, and the first cloud-tuft was formed. And we must bear well in mind what Mr. Eliot says: *—

"(5) That the development of the cyclone proper was, however, due to causes and action confined almost entirely to the Bay, originating and intensifying there without exercising any marked effect on the meteorology of the

* Page 142 of his Official Report of the Backergunge Cyclone of 1876.

coast districts until it was fully formed and proceeding towards the head of the Bay. Hence the immediate causes of the cyclone formation and action must be sought for in the meteorology of the Bay itself during this period."

At pages 471-472 of Maury's book we read :—"The solid land crust has its temperature raised by day and cooled low down by night; but the most powerful sun, after beating down all day with its fiercest intensity upon this liquid covering, has not power to raise its temperature more than three or four degrees. This covering serves as a reservoir for the solar heat. In the depths below it is concealed from the powers of intense radiation, and held by the obedient ocean in readiness to be brought to the surface from time to time, and as the winds and clouds call for it. Here it is rendered latent by the forces of evaporation, and in this form, having fulfilled its office in the economy of the ocean, it passes off into the air, there to enter into mysterious ways upon the performance of its manifold tasks."

"891. *The reservoirs of heat* :—Thus we arrive at the conclusion that the ocean is the great reservoir of sensible heat, as the clouds are of latent heat. That in those two chambers it is innocuously stored, thence to be dispensed by processes as marvellous as they are benignant and wise, to perform its manifold offices in the economy of our planet: it is this heat which gives 'his circuits' to the winds and circulation to the sea;" * * * * * *

"892. Thus perhaps we discover a new office for the waves in the physical economy of the ocean. Is it not to them that has been assigned the task of bringing up by their agitation of the surface the layers of warm water that are spread out below; and are they not concerned also, as they draw up the genial waters, in regulating the supply of heat for winds by night, as well as in cold or cloudy days, for the purposes of evaporation? Thus even the waves of the sea are made by this beautiful study to present themselves as parts, important parts, in the terrestrial machinery. We now view them as it were like balance-wheels in the complicated system of mechanism by which the climates of the earth are governed." But we must not omit 890 at page 472, which says,—"As evaporation goes on by day or night, the upper stratum is

rendered heavier by reason of both the heat and the fresh water borne away by evaporation, the upper water having been thus rendered both salter and cooler, has its specific gravity increased so much the more. On the other hand, the strata below, receiving more heat by day than they dispense again by radiation day and night, grow actually warmer and specifically lighter; and thus, by unseen hands and the 'clapping of the waves,' the waters below are brought to the surface, and those on the surface carried down to unknown depths; and thus, also, we discover new and strange processes which have been ordained for the waters of the ocean in their system of vertical circulation."

Mr. Blanford, in his Indian Meteorologist's Vade Mecum, says at page 244 :—" In the cyclones of the Bay of Bengal, there are no such changes of temperature as characterise the storms of extra-tropical regions. Throughout the storm and in all parts of it, the temperature is almost uniform; and, generally speaking, the average temperature of saturation for the time of year. In the October storms this is between 75° and 80°: there is a very obvious reason for this. It has been explained in the introduction and at section 51, that the Himalaya bars access to any polar wind currents, and the air which chiefly feeds the cyclone is drawn from the Bay of Bengal, the indraught from the land area around being comparatively small."

And here we may quote again from Mr. Blanford's above-named useful book, when speaking in page 195 on the potential energy of vapour which is locked up in the act of evaporation from a water surface. Mr. Blanford adds a footnote to set those right who misname it "latent heat." "The term 'latent heat' originally proposed by Black, has become so widely used, that its abandonment would now be attended with much difficulty. But 'latent heat' is no more heat than is the momentum of a moving railway train, or the potential combination of an unignited lucifer match. Instead of being set free as heat, it may become momentum, and before being absorbed by the evaporating water, it may have been stored up for ages as a bed of coal."

The above explanation of what the potential energy is, and the mistake of the term "latent heat" will, I think, help us a great deal, as we go on searching out these very interesting phenomena of ocean and air.

As is water vapour to the atmosphere above us, so, doubtless, the salts of the sea are the instrument or ready means whereby the heat from the sun's rays can do its required office of keeping in circulation and never-ceasing motion (vertical and lateral) the great oceanic depths.

Now, as Mr. Blanford tells us above, the air temperature in these cyclones of the Bay is from 75° to 80°, and as, during the calm state of the weather for some time previous to the storm, the blue seawater has probably been heated up to above 90° degrees, there is 15° of heat from this large expanse ready to give off potential energy in the evaporation of its surface water as fast as the thirsty winds take it. We have proofs of the waters of the Indian Ocean (or as Maury terms it,—" the great intertropical caldron of India," or as Mr. Eliot in his Report on the Madras Cyclone of May, 1877, calls it, " a water-area of high temperature over which there is continuous rapid evaporation") being heated up to a temperature of 90°, as in Maury's book above quoted, at page 198, we read,—" * * * this area is land locked on the north, and the temperature of its water is frequently as high as 90° Fahrenheit," before the tumult of the elements, by which the waters, as Maury says, " are shaken up as in a phial." And again, quoting from Mr. Eliot's Report of the Backergunge Cyclone of 1876 at page 182, we read,— " On the 20th and following days a clear sky and warm weather prevailed over the greater part of the Bay. Evaporation was probably taking place at a much more rapid rate than the above (two-tenths of an inch). The amount of heat absorbed by the conversion of this amount of water daily over so large an area as the Bay of Bengal is enormous. Roughly estimated, it is equal to the continuous working power of 300,000 steam-engines of 1,000 horse-power. * * * There was thus a process of absorption of heat, and therefore of mechanical energy, by the atmosphere over this area, compared with which even the energy of the moving mass of air during the cyclone and of the disturbed and elevated water surface over which the cyclone passed was small."

So, there can be no doubt but what the accumulated sensible heat of the glassy, blue, salt waters of the Bay, even after the still atmosphere above has had its fill of "potential energy," play an important part in both the creation and maintenance of these cyclones, as we read in Maury's book abovementioned, at page 62, speaking of the gulf stream,—"To use a sailor's expression, the gulf stream is the great 'weather-breeder' of the North Atlantic Ocean" * * * "With such an element (*its sensible heat*) of atmospherical disturbance in its bosom, we might expect storms of the most violent kind to accompany it in its course. Accordingly the most terrific that rage on the ocean have been known to spend their fury within or near its borders, &c., &c." And referring to pages 194-195 of the same work (Maury's) above quoted, we read:—

"*The Lagullas current and the storms of the Cape:*" "It gives rise to the most grand and terrible displays of thunder and lightning that are anywhere else to be witnessed. Missionaries thence report to me the occurrence there of thunder-storms in which for hours consecutively they have seen an uninterrupted blaze of lightning and heard a continuous peal of thunder" * * * "He has pointed out from the abstract logs at Utrecht, the existence there of some curious and interesting atmospherical phenomena to which this body of warm water gives rise. The storms that it calls up come rushing from the westward; sweeping along parallel with the coast of Africa, they curve along it. Though so near the land, they seldom reach it. They march into these warm waters with furious speed, reaching them with a low barometer they pause and die out."

Concerning the currents on the Coromandel Coast, we read in Findley's Sailing Directory, page 186:—"In September: 'There are many anomalies in the currents at this season, for while they run with great strength to the north-east, near the coast, they are feeble in the offing; and when they run to the north-east in the open seas, they are inappreciable near the land.'" And when we come to consider that there are great and constant oscillations both of baric pressure and temperature going on

between the sea and land areas of Bengal, especially at this season of the year, when the sun has been playing so fiercely on them, we can quite understand the many anomalies which Lieutenant Heathcote, in the above extract, seems to have observed: and, here, we may with profit once more quote Captain Maury, who says at page 47 of his Physical Geography of the Sea:—"The waters of the gulf stream form by no means the only body of warm water that the thermo-dynamical forces of the ocean keep in motion. Nearly all that portion of the Atlantic which lies between the gulf stream and the island of Burmuda has its surface covered with water which a tropical sun and tropical winds have played upon—with water, the specific gravity of which has been altered by their action, and which is now drifting to more northern climes in the endless search after lost equilibrium. This water, moreover, as well as that of the gulf stream, cools unequally. It would be surprising if it did not: for by being spread out over such a wide area, and then drifting for such a great distance and through such a diversity of climates, it is not probable that all parts of it should have been exposed to like vicissitudes by the way, or even to the same thermal conditions: therefore all of the water over such a surface cannot be heated alike; radiation here, sunshine there; clouds and rain one day, and storms the next; the unequal depths; the breaking up of the fountains below, and their bringing their cooler or their warmer waters to the surface by the violence of the waves, may be all expected, and are well calculated, to produce unequal heating in the torrid and unequal cooling in the temperate zone; the natural result of which would be streaks and patches of water differing in temperature."

And thus, independently of the wind-direction blowing over its surface, can we not descern in all, or any of the above causes, motive power competent to set up a gyration in the sea: and which medium, as is well known, propagates a vibration of energy with 4¼ times the intensity and speed that an air medium is capable of doing?

All the logs of vessels caught in these cyclones give abundant proof of a great whirl in the sea as well as in the air; and I know from experience, it runs at the rate

of five or six knots westwards within the 15-fathom line of soundings at the Sandheads: even before the full fury of the storm has burst; the sea revolving, as does the air above it, cyclonically or against the sun or watch-hands. And so we find with regard to the sudden impulse,—the vibration of dynamic force imparted to the hitherto comparatively slow-moving sea-current, which pours over the tails of the sands off the mouth of the Hooghly on the advent of a great cyclone, or, both before the full fury of the storm bursts, and whilst it is in progress; the winds alone are certainly not the only cause to which we are to look and seek for it, for, as I have elsewhere noticed, a westerly current of some strength shows itself long before the north-east precursory winds have set in, or have attained to any force; and, too, before even any visible signs of the coming storm show themselves aloft, such as a bank of pallio-cirrus to the south-east, or lightning to the E.S.E., or any signs of a swell from south-east.

But rather, its rapidly increasing energy is to be sought in the thermal contraction of sea-water, as, beneath the suddenly formed sunscreen of pallio-cumulus, it delivers up to the thirsty storm-winds its contained sensible heat in the heat-vehicle, vapour, which it gives off so copiously as the gusty squalls stir up the long-becalmed and superheated depths, into white-crested and foaming waves.

For, Maury says at page 468 of his Physical Geography of the Sea,—"The heat of the sun penetrates to, and is retained as sensible heat at, about a depth of 10 feet below the surface of a smooth sea." And at page 473 we are told how "the winds stir up the waves of the ocean, and so cause them to deliver up the stored-away sensible heat as latent heat" (rather it should be, as Mr. Blanford puts it, 'potential energy'), "the very life of the storm, in the heat-vehicle, vapour, which the wind greedily licks up and transfers to the cloud region aloft:" and, too, Mr. J. Eliot's Report of the Madras Cyclone of 1877 says:—

That, "at least for three weeks before its formation the sea was smooth and the sky was unclouded;" also, that

"there was an increased temperature of the sea area:" of course, consequent on the sun's rays penetrating to the retaining floor of Maury, 10 feet down. So, on the whole, this thermal contraction alone of the beclouded sea area, within, would be sufficient of itself to cause a considerable indraught, and consequently a circulating spiral movement of the surrounding, still heated, waters beyond it, and on which, probably, the sun is still shining fiercely down.

But, while the thermal difference between 90° and 75° (which is the fall of temperature in cyclones of the Bay) gives a change in volume of seawater of ·00282, the current set up by it will be further augmented by the sudden fall in the barometric pressure over the same area.

Then again, there is the sudden advent of torrents of fresh rain-water to alter the specific gravity and volume of the sea surface and send it rushing hither and thither in search of lost equilibrium: as Maury tells us at pages 408 and 409 of his book above quoted, when speaking of how much a fall of a single inch of rain over an extensive region in the sea, or how much the change even of two or three degrees of temperature over a few thousand square miles of surface, tends to disturb its equilibrium, and consequently to cause an "aqueous palpitation that is felt from the equator to the pole;" and, who ends by saying:—"And yet there be philosophers who maintain that evaporation and precipitation, changes of temperature and saltness, and the secretions of insects, are not to be reckoned among the current-producing agents of the sea. That the gentle trade winds do it all."

In his Indian Meteorologist's Vade Mecum, Mr. Blanford says:—

"The atmosphere, unlike the ocean, is undivided and uninterrupted, and every change of state in any part of its expanse sends forth a pulsation of energy which is speedily felt far and wide."

Now, if the impulse transit period of an air medium is only 1,140 feet in a second, how much more speedily will a change of state be felt far and wide in a water

medium such as the enclosed but uninterrupted waters of the Bay of Bengal, when its impulse transit period is as much as 4,700 feet in a second.*

And, now, we may as well search amongst ship's logs for some evidence of the currents of the sea showing that there is a whirl in it as well as in the atmosphere above it during these storms.

I found when at the Sandheads on board the "Iron King," in the cyclone of June—July, 1872, we were carried some 60 or 80 miles to the eastward of our dead reckoning, on the southern verge of it; whilst the vessels on its northern verge were carried to the westward. Thus we read in Mr. Willson's Report of the Midnapore and Burdwan Cyclone of October, 1874:—

That the S. S. "Sir John Lawrence," steaming head to wind, drifted S.E. 120 miles out of her dead reckoning, at the rate of 4 miles an hour, from abreast of Point Palmyras to the latitude of Ganjam.

On 7th October, 1876, the S. S. "Satara" on the north-eastern verge of the Vizagapatam Cyclone, felt a set N. 18° W. of 14 miles in the 24 hours, and the next day with wind from south to S.W. she felt a set S. 73 E. of 14 miles in the 24 hours.

On 11th October, 1876, the S. S. "Ethiopia" was set 25 miles to the south of Gopaulpore (to which place she was bound) in 24 hours: "strong current to southward about 20 miles off the land."

Between the 1st and 6th of November, 1876, immediately after the breaking up of the Backergunge cyclone, the ship "Tennyson," between Lat. 18° 54′ N., Long. 89° 33′ E., and near the Sandheads, had light northerly winds with a strong W.S.W. current.

* Well do I remember when coming out to India in March, 1861, and the day we crossed the equator, how the timbers of our old ship rattled again, during an earthquake in the Brazils; although we were hundreds of miles from the coast, and had a cushion of water beneath us of several thousand fathoms; and even the noise of it was loudly audible. I also remember hearing the boom of the nine o'clock gun of one of our vessels of war at a distance of over 30 miles: that was, from Saugor to the Sandheads, and against a light wind. The sound came like a thud on the ear, and was doubtless transmitted by the water, as was the sound and concussions of the earthquake above noticed.

The ship "Allahabad" in the same cyclone and on its eastern edge with winds from E.S.E. to S.E. experienced a strong current to N.E. during the cyclone on Tuesday (the 31st October). This was in Lat. 19° 10′ N., Long. 90° 48′ E., and on the two previous days between this position and 14° 53′ N., 19° 10′ E., with wind strong S.E. to E.S.E., she found a strong current setting northward.

The ship "Lightning," caught in the same cyclone at the Sandheads with winds from about N.E., reports—"Noon, 1st October, 1876, got observations: Lat. 19° 40′ N., Long. 87° 30′ E., finding our position about 90 miles more to the S.W. than I expected; for I feared that the storm-wave coming up in that fearfully heavy southerly sea-swell we had, would have set us to the northward, but we find we were fairly set to leeward, as the wind blew from the north-eastward."

Also in Mr. Eliot's valuable Report of the Madras Cyclone of May, 1877, we read that the ship "Mofussilite," on the 17th, in Lat. 9° 56′ N., Long. 88° 29′ E., with strong S.W. gales, had a strong current to the south-east; and on the next day, in Lat. 10° 39′ N., Long. 81° 44′ E., same weather and wind, had strong current to E.S.E. On the 19th, Lat. 12° 17′ N., Long. 79° 54′ E. (in sight of coast), with fresh S.S.W. breeze, had strong current to the southward. But this last one was far south of the Sandheads.

Still, after all we have learnt, it perhaps is as well to take our prevailing wind direction, especially if it has any easting in it, and expect the waters to be setting the same way over, and off the tails of the sands off the mouth of the Hooghly, and act accordingly; as it is impossible to know what changes are in progress out over the Bay, and it is not so easy to find out if there is any set, unless some fixed object is in sight or your vessel is anchored.

And, now let us pause a while to consult another celebrated authority on this branch of those physical laws of the universe, which, as the late Canon Kingsley declared ("whether we be conscious of them or not) are all around us, like walls of iron or adamant—say, rather like some vast machine ruthless though beneficient, among the wheels of

which if we entangle ourselves in our rash ignorance, they will not stop to set us free, but crush us * * * * Very terrible, though very calm, is outraged nature." An authority, who, at a lecture given at Simla in September, 1880, on the Indian Monsoon Rains, said:—

"But although we cannot control the weather any more than we can still the earthquake, or extinguish the volcano, it may still be possible in some measure to lessen, and foreseeing, to prepare to meet whatever vicissitudes may be in store for us. Capricious and lawless as seem the changes of our weather and the irregularities of our seasons, no physicist doubts that they are conformable to law as are the rising and setting of the sun, or the ebb and flow of the tides; and such being the case, a knowledge of the chain of processes by which they are brought about is, as far as we can see, only a question of time and patient enquiry."

Mr. Blanford says at page 205, Indian Meteorologist's Vade Mecum:—

"What, indeed, might be the final condition of the atmosphere if it were motionless, if saturated air were never to flow away toward cooler regions, and to be replaced by in-flowing and descending currents of drier air, it is somewhat difficult to realize; and the speculation is without practical application. But we have a very practical illustration of what takes place over tropical seas, when the generated vapour is not carried away by lateral current, *viz.*, in the belt of calms and heavy rains over the Atlantic, and, in the conditions which precede the formation of cyclones in the Bay of Bengal and other seas, sufficiently distant from the equator to allow of the operation of Ferrol's law." (A law whereby every moving thing in the northern hemisphere is impelled to the right of a straight line consequent on the earth's rotation impulse.) "These are tracks of heavy rainfall, chiefly diurnal in the belt of calms, but continuous and increasing in the cyclone cradle."

And at page 198 of the same we read:—

"The vapour which originally is absorbed by the lowest stratum of the atmosphere, tends to diffuse upward, until the distribution shall be the same as if no air were present. If the temperature of this vapour atmosphere were uniform throughout, this final or limiting condition would be such that the logarithm of the pressure would decrease in a

simple ratio of the height, and the vertical thickness of the vapour atmosphere would be about $1\frac{3}{8}$ times as great as that of air. But this final condition can never be attained. In the case of air, the diminution of temperature only renders the higher strata more dense than it would be with an uniform temperature; but in the case of vapour, it brings about condensation, and thus renders the atmosphere a still, on an enormous scale; the sun's rays and the watery surfaces of the earth being respectively the fire and boiler, and the cloud-bearing strata which are cooled by radiation and convection, the representatives of the condenser."

So we thus learn from both Mr. Blanford's and Mr. Eliot's writings on the subject of Indian Meteorology, that consequent on this state of the atmospherical phenomena, this struggle of well-balanced forces, there is in October all around the coasts of the Bay a very general tendency to equilibrium of aërial pressure, humidity, temperature, and air motion; the latter becoming almost *nil*, both around its coasts and over the whole area of the Bay: thus favouring the formation of a great cyclone by giving no facility or aid to the superheated vapour, rising copiously from the sea, to escape in any direction in the upper regions of the atmosphere: so that it has to rise, and rise, and, as a consequence of its uprising, condense into cloud and then rain, over the place of its production, leaving its potential energy—its sensitive heat—behind to further expand the air of the upper cloud stratum, and by heating and expanding, push the already overflowed surplus far away from the up-take: thus, by creating an upward flow of indraughted air, also laden with vapour and heated, lowering still more the baric pressure over this the "cradle of the cyclone:" and then follows a general rush from all sides (more epecially from S.W. and W.S.W., where the pressure is superior), and a cyclone of greater or less dimensions and formidability is started on its course over the Bay, direct as the crow flies, towards that part of the surrounding coast, where the wind force, or air motion, happens to be the least.

The usual cradle of the heavy October cyclones is a few miles to the N.W. of the Andaman Islands. Their advance is but slow at first, but, on nearing land, they have been known to travel at the rate of 20 miles an hour, and are accompanied by a great storm-wave, which rises sometimes 40 feet over the low-lying shores of Bengal. Those of October are the most destructive of all recorded cyclones, far exceeding those (also destructive) ones which form up during the April—May transition period.

Their approach to the Sandheads is always heralded first by an abnormally high glass, clear brassy sky, and sultry weather, with smooth sea. Then, by a gradually freshening N.E. wind; distant flickering lightning to the E.S.E.; a bank of clouds, at first light, but which afterward grows dense, gradually rising out of the S.E. quadrant; and which, as it attains an altitude of 45 degrees, sends out, now and then, fringes or detached bands, which cross the N.E. surface wind and melt away in the N.W., the particles or cloudlets of which show a strong motion from the S.W.: and a set of the sea to the westward rapidly increasing in strength, so that it becomes dangerous for ships to be caught high up in the channels, which run between the long ridges of sand (see Hooghly Sub-Marine Sand-dunes, 359), running seawards S. by E. ½ E. to S.S.E., 30 to 35 miles from dry land. Then the S.E. swell, at first low and long, rolls in, making the vessel, as she lies in its trough, roll her sides pretty deep into their hollows now and then.

The sky also, long before sunrise, high up, has a red glare in it,

> "Like a red morn, that ever yet betokened
> Wreck to the seaman, tempest to the field,
> Sorrow to shepherds, woe unto the birds,
> Gusts and foul flaws to herdsmen and to herds,"

on the advent of a cyclone in October: and the clouds all around from S.E. to N.E. are tinged for hours after sunrise

with the same dark fiery red.* Even the northern and higher parts of the ominous S.E. bank partakes of it as it steadily but surely rises out of the sea like distant high land of a slaty blue, broken here and there by darker "thunder-heads" emerging from its midst: and with belts of white smoky-looking cumula from the north-eastward drifting across it low down. And at sunset, the clouds hovering about present greenish and gaudy tints.

* At page 166 of Blanford's "Vade Mecum," we read :—"Both air and vapour are highly, but not *absolutely*, transparent to light, more especially water vapour. Certain dark lines and bands in the solar spectrum are due to the absorption of particular rays by the atmosphere, and Forbes and Jaussen have observed that water vapour, when in great thickness, exercises a very appreciable and general absorption of the blue and more refrangible rays of the spectrum, and of certain bands in the red; while the greater part of the red and orange rays are freely transmitted. Hence the brilliant red and orange tints of the clouds at sunset, at which time the solar rays traverse a great thickness of the lower atmosphere, highly charged with vapour."

The following is from a Lecture by Mr. Scott of the Meteorological Department, London :—

"Optical signs of the weather mostly concern the condition or amount of aqueous vapour in the air. The colour of the sky, one of the most trustworthy prognostics, was regulated entirely by the state of condensation of the suspended water vapour. The successive layers of air charged with vapour stop the different rays of light; firstly the blue, then the yellow, and lastly the red. When the sun is near the horizon, the rays have to traverse a great thickness of vapour, and so the last rays at sunset and the first at sunrise are red. The truth of the old rhyme, 'Evening red and morning grey,' &c., may be thus explained. The disappearance of clouds at sunset is a sign of fine weather, for it is due to the sinking of the clouds into the warmer strata near the surface of the earth, where they are evaporated. These clouds in disappearing leave behind them a large amount of vapour in the air, and the sun's rays shine red through this medium. In the morning the air is comparatively dry after the cold of the night, and the blue and yellow rays are not stopped in their transit, so that the clouds look grey from a diffused light. Conversely, a grey sky in the evening is caused by the presence of such a mass of clouds as to stop the sun's direct rays, and to allow nothing but diffused light to pass; while in the morning the red and lowering tints of the clouds show that the air is full of watery vapour close to its point of condensation."—*The Leisure Hour, No.* 1315, *March* 10*th*, 1877.

The barometer, which has ranged high of late (see Barometric table, 380), falls a little; but its fall, as the weather or sky gradually darkens, is, comparatively speaking, small. But at length the weather begins to look serious and ugly, and rain falls in the gusts of N.E. wind, now blowing a fresh gale, and which is hurrying long low ridges or bands of scud along beneath the dark pallio-cumulus. The wind still persistently hangs to the N.E.

All this may have taken one or two days to occur, while the barometer (which two days ago stood at perhaps 29·80) has fallen to 29·50, or perhaps 29·40. At last the heavier and heavier rain squalls, the rapidly falling barometer, and the breaking rollers tell that the vortex is near; and then, and not till then, does the wind veer or haul out of the N.E. But now the hurricane rages and lays the vessel on her beam ends, enveloped in foam and blinding spray of sea-water dust and rain (and mixed with mud and steel filings, the peculiar sand found in the silt of the Hooghly, if the vessel is within the 20-fathom line of soundings).

Such is the onslaught of one of those fearful storms, the prognostics of which, the result of my 18 years of close observation, are faithfully portrayed in my little book—"The Sailors' East Indian Sky Interpreter:" and to which I refer the reader for further information about the sky effects, &c., which usually usher in these and all the cyclones of the Bay of Bengal.

In the cyclone of October, 1874, the barometer on board the Pilot Brig at the Sandheads fell from 29·30 at 7 A. M. to 27·60 at 11 A. M., and from noon to 0h. 45m. P.M., she was in the central calm, during which time numerous land birds, as usual, fell on the deck exhausted, whilst the sun shone down with a strange glare through a round hole in the dense dark cloud screen, until the storm once more burst upon her from S.W. with redoubled fury and lasted for 5 or 6 hours.

During the height of the burst from the S.W., her main hatch, tarpaulin and all, was drawn or sucked up; and a

heavy skylight flap, measuring 7 feet by 5½ feet, and weighing 180 lbs., opening out athwartships, was repeatedly banged up and down on its massive hinges by the great uplifting force of the eddies that whirled round and over the vessel.. The vessel, at the time, certainly had a heel or list of, perhaps, 25 degrees, the skylight was fortified by planks laid close across it 2½ feet below the flaps.

But when we come to remember that these winds pass over at the rate of 100 miles an hour,* we cannot be surprised at the quick recurrence of gust and lull as the hurricane sweeps along over the oscillating sea surface, and whirls and eddies for a moment round and over the hull of the ship, ere it passes on towards the great central up-take of the cyclone.

To show that there are those afloat who are aware of those freaks of the windy whirls, I may mention that, but about a month before I saw all this take place on board the pilot vessel, I was put on board the inward-bound ship "Edith Warren," and on noticing her main hatches were secured with 2-inch planks laid across over the tarpaulins and well secured with chain lashings, I remarked to the worthy old gentleman in command of her—Captain Samuel Clark—I supposed the planks were to save the tarpaulins from being torn by the wash of water over the hatches; but little did I think I should see realized so soon what he said to me in his answer: "Aye my boy, I see you have not been long enough at sea yet to see the hatches blown up."

Thus we see there ought to be other fastenings to the hatches besides the edges of the tarpaulins nailed down to the combings, to withstand the uplifting force of the eddying winds of a cyclone or hurricane, and it may not be impro-

* The following is from a Calcutta Weather Report, dated 12th May, 1881:—"According to a report received from the Alipore Observatory, after the issue of the report yesterday, the maximum pressure of the wind during Tuesday's storm was 55 lbs. per square foot, corresponding to a theoretical velocity of about 115 miles per hour."

bable that some of the "missing" vessels have gone to the bottom, through the hatches being "washed" off as it is called; in fact, as I heard it explained about three years ago concerning a steamer which I piloted shortly after she had narrowly escaped foundering in a cyclone in the Bay.

And here it may be profitable to pause a while and discuss the actual cause of this uplifting of hatches in heavy breezes of wind—a phenomenon of great interest to the sailor there can be no question.

There is no doubt but what it is the sudden rush of a gust of the hurricane wind across the vessel, causing, for the moment, a difference of aërial pressure beneath and above the hatch; a decrement above, whilst the pressure below it remains the same as before the gust came, its very suddenness preventing the difference of pressure being communicated by the various channels, through chinks in skylights, booby hatches, or ventilators, in time to prevent the hatch rising to its impulse; just as the sudden impact of the fast fleeting ricocheting cannon-ball upon its surface gives the inert water no time to receive some of its impulse and move aside, so as to allow it to sink; or, just as the fast-rising temperature over Calcutta at 10 A.M., failing to communicate its expansive force to the different atmospheric layers at once, and in time, acts upon and forces the mercury up the tube of the barometer (see Blanford's Vade Mecum, pages 186 to 189).

It is a well-known fact that the barometer is in a constant state of oscillation during these storms, showing well the vibratory character of their winds, and, doubtless, could the vacuum box of the aneroid communicate the quickly varying pressure to the chain and spring, and these to the pointing hand in time, the rise and fall in its height would be much greater; as it is, the aneroid is always much more lively in a storm than is the heavy and sluggish mercurial column. So that, probably these oscillations of the barometer simply indicate how high the mean range of one set of, pos-

sibly violent oscillations of pressure, is above another set; for as time is concerned here, we must not consider these oscillations of the barometer to be a faithful mean of all the greater or lesser oscillations, as we do with the deviation of an iron ship's compass where time is not concerned; with reference to which, it is well known that the compass needle simply shows the mean direction in which the whole of the magnetic currents are flowing through all the several pieces and masses of differently worked iron and steel, about and near its position.

A N.E. wind if it holds, being, at the Sandheads at least, a sure precursor of a cyclone, it always tells me to look out well to the E.S.E. during the transition periods for flickering flashes of distant lightning—the next sure sign; and I may here mention that lightning first seen anywhere over the sea, which, of course, is the effect of rapid condensation of vapour, augers bad weather, sooner or later, all through the S. W. monsoon, or in fact all the year round; and this lightning to the E.S.E. has, on very many occasions, confirmed me in my opinion that there was a disturbance down the Bay, so that I have for the three years, 1877, 1878, and 1879, in the month of October, written warning letters to the *Indian Daily News* to that effect; and a short time sufficed to show that I had premised correctly; ships and lives—precious lives—being lost on each occasion.

A sure sign of the heavy bank of clouds which has gradually risen out of the south-east being a cyclonic storm, is, when the edge of it has reached your zenith, the fringe of mottled *ci—cu,* or "mackerel back" looking *cu,* is seen to be moving up from the south-west very rapidly, and right against the fresh north-east surface current, which is already carrying low scuds with it and spitting down a few spots of rain. This motion to the north-east of this cloud fringe, I take to be the anti-cyclonical motion of the overflow from the higher regions over the great up-take of heat in the heart of the cyclone: or, as we read in Maury's excellent fourteenth edition of

his Physical Geography of the Sea, and as I infer, is an idea of Captain H. Toynbee's, "the condensed vapour, which spreads out at top like a great mushroom in the air, the liberated heat adding fury to the storm." Mr. Blanford tells us that the air which is constantly poured into a cyclone passes upwards in a convection current, after which it is dispersed in an anti-cyclone in the upper atmosphere; see page 252, Indian Meteorologist's Vade Mecum.

This part of the phenomenon of a cyclone I have over and over during the past 12 or 14 years seen and noted in my log-books when storms have been raging in the Bay away to the southward of the Sandheads. And such was the case at the Sandheads on the night of the 1st November, 1878, when, with a fresh N.E. wind, these clouds (not very high) were crossing the moon's disc very rapidly indeed, right against this N.E. surface wind and scuds, and that night I waited until the moon had set (after 3 A.M.) and then watched to the E.S.E. for my other certain cyclone prognostic; and sure enough, about every three or four minutes I saw there, "the flickering flashes of lightning which tell that there is a storm or cyclone in the Bay, though their faintness denote it is yet far away" (as set forth in my little book above-mentioned). My letter dated the 1st November appeared in the newspaper on the morning of the 3rd November, 1878, and that very day (we afterwards learned) a cyclone struck the coast, and caused great damage, at Vizagapatam (300 miles from Calcutta), whilst (at Calcutta) about noon, this same cloud bank brought N.E. and E.N.E. rain squalls.

I find when first this bank makes its appearance, the course of the storm may be deduced pretty correctly, by noticing the altered bearings of its central part, and taking frequent bearings of the two portions which, right and left, are arched over and dipping beneath the horizon.

Right through this season, October to January, I have always found that a N.E. wind brings with it this inevitable dark S.E. bank, and a change of weather—a distur-

bance down the Bay somewhere; and which also sends in its swell, though the place of the storm may be far away down to the southward: and, as a rule, the fine weather winds in both monsoons are, for the winter, northerly, with nothing to the eastward of N.N.E. in them; and, for the summer monsoon, southerly, with nothing to the westward of S.S.W. in them; these notes, of course, are meant for the Sandheads only.

It augers good, if, like it has done in 1880, the southerly winds and rainfall hold sway well into October; but as there is little difference of pressure over a large area to cause wind, this month is generally one of calms and light easterly and northerly winds.

The winds in a cyclone are evidently confined to a stratum near the earth's surface, as all who have been through one, must have seen the dark masses of motionless (that is, lateral motion) cloud which now and then show through openings in the misty scuds fleeting with the surface wind: and these cloud banks towering aloft have frequently arches of cloud of a darker hue than the leaden banks behind them, showing the circular form of the "up-take."

And here we may as well quote the late Admiral Fitzroy as throwing some light on this part of the subject:—

"It is sometimes found that cyclones, instead of passing horizontally or parallel to the earth's surface, are inclined at an angle (more or less acute) with the horizontal plane, and we, therefore, feel only parts of them; there may be several such circulations passing or following in the same direction, and revolving similarly like eddies, with their lower portions, on one side only of the circulating meteor, touching the earth's surface, the other parts circling above our heads, so that we may only feel a part of the change, and not the whole of the movement."

And in some of the minor cyclonic storms, the winds are seen to carry the clouds along at hurricane speed aloft, whilst below, there may be only strong or fresh winds. I remember, late in October, 1864, when on board of a pilot brig at the Sandheads, a small second whirl followed the

great cyclone of the 4th of that month up as far as the Pilot Station; and at 2 A.M., we pilots were summoned on deck by the commander of the brig, Mr. T. Smart, to stand by to assist in cutting away the masts, if it should be deemed necessary so to do. The wind was howling up aloft, whilst on deck we had merely a moderate gale, and were able without difficulty to furl the quarter deck awning out of the way. Well, all this took place somewhere in the vicinity of the Eastern Channel Light Vessel, whilst on that same night the ship "Hotspur," Capt. H. Toynbee, also the ship "Alnwick Castle" with troops on board, rode it out at anchor somewhere near the Mutlah Light Vessel. The "Hotspur" losing her three top gallant masts, although her top gallant yards were on deck, and, besides, each mast was secured by extra stays: which I remember Captain Toynbee called my attention to, when I visited his vessel at Middle Point a few days afterwards, telling me how astonished both him and his officers were when they looked aloft during the breeze, and saw the top gallant masts hanging down a wreck. And if I remember rightly, the pilot vessel, though her top gallant yards were, like the "Hotspur's," on deck, had both her top gallant masts sprung. The "Alnwick Castle" lost her three topmasts at the cap: and the French bark "Bordeaux," also in the vicinity of the Sandheads, lost her two top gallant masts likewise.

I am borne out in my assertion that the wind hangs persistently at N.E. until the burst of the cyclone's hurricane wind is close to, by a remark of the late Mr. W. G. Willson in his official report to Government of the Midnapore and Burdwan Cyclone of 15th and 16th October, 1874. At page 13 he says:—

"Up to the early morning of the 15th October, there was nothing in the behaviour of the barometer at Calcutta, or in the character of the weather, to foreshadow the approach of a cyclone, with the exception of the prevalence of north-easterly winds." * * * * "I find from my notebook that at 2-10 A.M. of the morning of the 15th, there was a sudden slight rain squall from N.E. This struck me at the

time as being peculiar and threatening, but it only lasted for a few minutes, after which the wind again fell light from the same quarter."

And at page 48 of the same Report, we read in Mr. Harrison's account of the effects of the cyclone in the Midnapore District as follows:—

"These returns indicate one result, which is contrary to what would have been expected, but which is thoroughly confirmed by the general experience in this district, *viz.*, that instead of the violence of the storm being greatest at its vortex, and next to that east of the vortex, and lastly west of it, the power of the wind was greater west of the vortex, next at the vortex, and least east of it. I do not know whether the surmise is scientifically possible, but the indications in this district lead to the inference that instead of the wind describing a circle, it described a curve, more like that of a six (6) [as the figure is written, not printed], the greatest power being at the first bend of the 6, opposite the vortex. Where the form of the cyclone circular, to places on the line of the centre, the wind should begin at right angles to the path of the storm, or in this case from the E.; and to places east of the vortex, the wind should begin from the S.E., while only to places lying west of the centre should it begin at the N.E. In the present instance, however, all accounts agree in representing the wind as beginning from the N.E. which the 6 shape would account for. Again it appears that the west side of the cyclone was far more clearly definable than the east side. In the one case, when one gets beyond the destructive belt, one soon loses all trace of the storm, and the damage is *nil*; but to the east side, no such easily definable line can be traced. A very high wind seems to have extended, even beyond Calcutta, which cannot have been less than 55 to 60 miles (eastward) from the vortex at its nearest point. It would thus seem as if the wind swept down from the N.E. in almost a straight line, at a constantly increasing rate, till it reached the level of the vortex, when it was at its maximum. After that, the centrifugal force seems to have been counteracted by the centrepetal (if it is legitimate to speak of such a force in a cyclone), and the result to have been a diminution of violence and a bulging out of the wind towards the E., due to centrifugal force.

"Whatever these theories may be worth, the fact remains that the heavy mortality and the maximum damage occurred with complete uniformity west of the vortex."

Mr. Willson also says in his Report at page 81:—"Before a cyclone, and during its approach, north-easterly winds prevail over many degrees of longitude to the north of the storm, both on the eastern side and on the western side of the path subsequently pursued, and there seems to be no marked tendency of the winds to circulate round a local depression until the cyclone is near at hand."

So that from what is noted above, it appears the N.E. wind is at least a suspicious wind: of course, I speak with regard to the Hooghly, its estuary, and the Sandheads. The N.E. is the proper wind for the winter monsoon over a certain part of the land surface of Bengal, and most likely the effect of the approaching cyclonic disturbance in some way causes it to veer from the N.N.E., its fine weather direction at the Sandheads, to N.E. But however it may be explained, it remains a fact that all the cyclones, and even most of those minor ones which form at the Sandheads during the rains, and travel over the land with their torrents of rain, if they are not ushered in by N.E. winds below, they invariably show by the way the anvil headed cumulus to the northward is turned, or cloud motion aloft, that there is a strong N.E. current up in the higher strata.*

And, again, I may remark here that, in all cyclonic storms, the shift of wind at the surface is invariably in-

* With reference to this precursory N.E. wind, the following is what used to take place at examinations of junior pilots:—Question by examiner: "You are outward-bound at Saugor and at anchor in a sailing vessel in one of the months, June to September, and find you have a fine N.E. wind in the morning, with a high glass fine weather, at what time of the tide will you weigh to go out?"

Answer by candidate:—"I will weigh at high water, sir."

Examiner:—"That will do, Mr. ——. You may go out of the room and come up again next examination day."

The proper answer would have been:—"I would move the ship to above Saugor Flat Buoy (*see* 18 & 347), and prepare for a gale."

dicated by the motion of the clouds aloft; for instance, say, wind E.N.E., I have seen the clouds above the scuds at the surface from about E.S.E. or S.E. and others (*ci—cu*) above that, showing a third direction, say, from South or S.S.W. Also before one of those bursts of rain in July, August, or September, the cyclonical system of spiral aërial currents show themselves well; for instance, my diary says as follows:

Thursday, 26th June, 1879.—From the 21st to yesterday, the upper parts of the towering *cumulus* clouds have shown a strong N.E. current, but yesterday, calm and sultry, I could see a N.N.W. current. A S.S.W. breeze sprung up during the evening, and to-day I see there has been a strong N.W. current all day, and now at 6 P.M. with the barometer ·08 lower than yesterday, I see three different air currents below as indicated by the scuds S.S.W.; next above this there is, in lines N. & S., rippled clouds from W., and above that there is mackerel sky, *ci—cu*, from N.W. or N.N.W.; the sky looks full of rain away to the N.E. Friday, 27th June, 1879.—8 A.M., barometer 29·53 (only ·01 higher than at 6 P.M. yesterday); wind 2 to 3 West, *o, u;* sky full of rain; *l* to the southward last night (a bad sign). 10 A.M., barometer 29·53; wind 2—3 W.N.W. to N.N.W., *o, r r*, dark and ugly. 4 P.M., barometer 29·47. The rain cleared off about noon, and the wind came round to about S.W. by W., or S.W. again, still looking rainy, but the sun comes out now and then. Saturday, 28th June, 1879.—A.M., wind 4 to 7 S.W. to W., *r r r*, and a heavy southerly swell all day (this is what the lightning meant). 8 A.M., barometer 29·58. Sunday, 29th June, 1879. —8 A.M., barometer 29·68; wind 4, S.W., *o*, dark, and raining now and then. 9 A.M., sea gone down; barometer 29·70. 4 P.M., barometer 29·64. There is still a northerly upper current, *o & g*.

So thus it appears, the bad weather is always heralded in by this visible spiral motion of the cloud system aloft: and I have always found it of the same character—the higher clouds are always coming from a direction to the right of the currents nearer the surface, and could quote instances like the above for years back; but, of course, the above was only one of those whirls of small extent which form at the Sandheads in the rainy season. Yet, I have no

doubt, the same may be seen on the southern verge of some of the heavy storms of October, and may serve to warn shipmasters bound up the Bay, and overhauling one which has not yet got far on its northerly course.

There seems to be a probability that cyclones do not sustain their perfect form, with a hurricane wind and calm central part, continuously right through its march, but that it now and then breaks up, or is swayed and swept for the time being off the surface of the sea, to impinge upon it again further on with redoubled violence; as we sometimes see the down-rushing eddying wind making repeated and fresh attacks on the heated dusty plain, carrying up fresh columns of dust and debris, as it whirls round the overheated and uprising convection current.

With the knowledge that the base of the cyclonic storm may not at all times be level or parallel with the sea surface, and may be only felt at the surface as a gusty hurricane wind by vessels on one quadrant only, we have only to suppose that all parts of a cyclone are equally dangerous and to be dreaded, and strive to keep clear of the centre. So, to that end, we should, if possible, keep the wind on the starboard beam and not right aft, as was advised by some of the more ancient, but not less valuable, works on cyclonic storms; for all our modern Meteorologists are agreed, that the centre of the storm in northern latitudes, bears a considerably greater number of points right from the wind direction than eight, or at right angles. In Mr. Blanford's Meteorologist's Vade Mecum, page 238, we read :—In the case of the storms of the Bay of Bengal, the following rule given by Mr. Willson is probably a fair generalization :—" With the face to the wind, the direction of the centre is from ten to eleven points to the right hand side." Then Mr. Blanford goes on to say :—

" It certainly varies, however, in different storms, and even at different times and in different parts of the same storm; and as a result of a comparison of the charts given by different describers, it seems to me that, on land and in

the neighbourhood of land, the direction is considerably more radial or less tangential than on the open sea. I am, however, entirely of the opinion of Mr. Meldrum and Mr. W. G. Willson, that a rigorous adherence to the rules laid down by Reid, Dove, and Piddington, which proceed on the assumption that the winds blow in a tangential direction, and which disregard their spiral convergence, is dangerous in practice and may lead to disaster. The cyclonic circulation of the winds is against the direction of clock hands (face upwards), or against the sun in the northern hemisphere."

With regard to the frequency of great cyclonic disturbances in October, I here insert a paragraph from Mr. Blanford's "Winds of Northern India," page 70:—

"The atmosphere over the Bay is then calmer in October than in May (see Wind Tables, 376 & 377), but storms are more frequent in the former month, and indeed, if we regard only those which disturb only the northern part of the Bay, one and-a-half times as frequent in October as in May. Consequently, a calm atmosphere or variable winds would appear to be a condition favouring the formation of cyclones, and this is verified by the facts of the few storms of which I have been able to trace the antecedent conditions."

And in connection with cyclone generation, the following extract from a recent lecture by the abovenamed gentleman on "The Indian Monsoon Rains" may throw some light:—

"In all cases heavy rain indicates that the air from which it is precipitated is ascending. Generally, below the cloud the air is calm; or at all events the wind is light; but air around must be pouring in to feed the rain; and thus we find that, between the region of heavy rainfall and the sea, a strong wind is blowing so long as the rain continues."

Perhaps, the old saw is not so far wrong after all, which says:—

> "When the rain comes before the wind,
> Topsail halliards you should mind;
> But with the wind before the rain,
> You can set your sail again."

364. **On making the Pilot Station**—October. As there is always more or less westerly set in October, com-

manders of vessels making for the Pilot Station, if they miss sighting the now permanently-stationed Mutlah Light Vessel, should endeavour to get soundings of from 12 to 15 fathoms to the eastward of Subtermooky or Lighthouse Sand (in 5 fathoms on its tail, the black ball by day, and the light at the masthead of the Eastern Channel Light Vessel by night, will just be above the horizon) (see 294), and feel their way with that faithful guide, the lead, over the tails of the sands, taking care not to deepen to more than 15 fathoms for fear of running to leeward of, and missing the Light Vessel, near which the pilot brigs are stationed. And many vessels have done so, seeing that the Hooghly Light Vessels are unfortunately painted of a colour (their hulls of a clay colour and mastheads, yards, and even rigging, white) calculated to deceive the eye should there be any haze on the horizon: for much difficulty will be found and valuable time lost in working back again, at this changeable and uncertain period of the year.

Care should be taken when stretching in with a N.E. wind not to get into shoal water on a weather shore, as did the ship "Prince Waldemar" in October, 1876, when she bumped her bottom in on the hard sands in the vicinity of the Mutlah Light: as she, in company of two or three others (who also seem to have narrowly escaped the same fate), were, in spite of the suspicious look of the weather to the southward, hurrying on to get a pilot. And I think 12 fathoms is the least water that a stranger should venture into, as the tails of the sands about the vicinity of the Swatch of No Ground are very steep to: and, besides, vessels are very liable to be carried more rapidly than the log shows they are, to the N.W., when on the N.W. edge of the Swatch, and to the westward over the tails of the sands by the westerly set pouring, as I believe, out of the Swatch, and which must be reckoned upon as strong in October, more especially if there are unmistakable signs of dirty weather brewing down the Bay. Nor would the best hawsers stand the heavy surges of a following ground swell if in tow

of a tug steamer : and for these reasons, and if the terrible fate of the brave crew of the "Prince Waldemar" would be avoided, the lead should be constantly and carefully hove.

A pilot is of very little use to a sailing vessel, when with a N.E. wind in October there is a strong set and threatening weather : and as an instance, I may mention that the ill-fated ship "Grand Duchess," in company with the "Mistley Hall," attempted to work in to Saugor Roads just before the fierce cyclone of the 15th of October, 1874 ; but when half way up the Eastern Channel, she had to anchor, and the set getting stronger and the cyclone bursting upon her, she was lost with all hands in the heavy breakers which lashed the Reef Head ; whilst the "Mistley Hall," some distance further up channel, just managed to get into Saugor, and fortunately rode the cyclone out. I believe a ship is much better off, if she has a good offing at sea, than when riding at anchor anywhere in the estuary of the Hooghly, especially at Saugor, where a heavy swell is felt : for the storm-wave severely tries the best made chain cables, when it makes up the contracted channels of the river.

A capital ready-at-hand sounding register is a common leaden syringe :—Unscrew the end and lay aside the piston and cover, then fit a cork to the syringe, fill it with water, and emptying it into the dram measure ascertain its cubic contents ; say, it holds 2 drams. Now cork it up, empty, and fasten it to the strop of the lead with its point upwards ; throw your lead, and, on hauling it up, hold the syringe over the glass dram measure, and taking out the cork allow the water to run into it : when, if the lead has been down $5\frac{1}{2}$ fathoms, it will bring up 1 dram of water ; if double that depth, or 11 fathoms, it will give $1\frac{1}{2}$ drams ; if double the last depth, or 22 fathoms, it will give $1\frac{3}{4}$ drams ; and if double, 22 fathoms, or 44 fathoms, it will give $1\frac{7}{8}$ drams, and so on. This being the effect of compression of the contained air by the superincumbent water at the above different depths. But, of course, a slight allowance is to be made for expansion or contraction by change of temperature which the contained air may undergo in the depths of the sea : and also for decrement of baric pressure ; but these allowances are comparatively

small, and I have found the syringe work well and sure in practice.

In October shipmasters should be prepared to find the pilot brigs at anchor (see 359). By the end of the month the winter monsoon may be considered to be fairly established ; but still, now and then, there will be a ground swell felt, more especially on the tails of the sands : but, as I have said before, beware of a N.E. wind, and especially about the minimum sunspot period (after the year 1885), when cyclones of great energetic force and extent are more frequently than at all other times formed at the two transition periods, April—May, and October.

During this month, as during the three or four preceding months, there are strong tide rips or eddies at the Sandheads, which frequently render the vessel quite unmanageable even though there may be a moderate breeze; these eddies are doubtless caused by the outset of the warmer littoral waters in conflict with the stream of sea water,* which probably pours up the Swatch of No Ground and trends away westward across the sands : of course they are stronger in the spring tides than in the neaps.

Vessels making the station during October would do well to have a kedge anchor shackled on to one of the bower chains, and ready to let go if, in the event of the wind falling light, the outset is drifting the vessel away from the Pilot Station; as, should there be any swell, there will be less danger of damaging windlass or of parting a chain when the time comes to heave up again.

For Tides, Winds, Baric Pressure, &c., see 376 to 382.

365. **November.** — During this month, Captain Maury tells us the north-east monsoon has pushed the place of equal contest as far down as the parallel of 5°

* See Table of Sea-set at Sandheads (379) ; compiled since the above was written. Also see footnote, page 149.

north. And Mr. Blanford, in his Indian Meteorologist's Vade Mecum, says of this month :—

"As the pressure continues to rise in Bengal, northerly winds advance further down the Bay; but they are, in general, light; and the north-east monsoon never has the violent stormy character that distinguishes it in the China seas. In this month, north-west winds blow over the delta connecting the north-west current of Upper India with the north-east winds of the northern part of the Bay in a continuous stream, and it can therefore be said that the north-east monsoon has set in."

After the 10th of this month, all fear of cyclones visiting the Hooghly are supposed to be at an end; but they have often been known in November to form down the Bay, and to do great damage on the western coasts: and even up to December, when, as in October, the south-east cloud bank above the meteor, as before noticed, invariably makes its appearance and more or less swell rolls into the Pilot Station, Sandheads.

The prevailing wind is from N. to N.N.E., which freshens up as the land grows cool at night, and slackens or dies away towards noon. And as the freshets are at an end in the rivers, and if there are no oscillations of baric pressure between land and sea areas to disturb and agitate the meteorological conditions, there is no, or very little, westerly set by the end of this month; vessels at anchor at the Sandheads swinging round the compass as the tide runs; but still the main body of the water can be observed to trend away to the westward. The weather begins to grow cool and the air dry as the month advances.

The pilot vessels will be found at anchor a short distance to the west and north of the Eastern Channel Light; and are very seldom found to the southward of the Light Vessel during this season: so that vessels must work to windward of the Light Vessel to obtain their pilots; and should watch the set of the tide and look out if signalled by the pilot vessel to anchor at high water, and not drift out to sea again. Should a vessel have to work to windward (or eastward)

to make the station, she should anchor at half ebb when the tide becomes unfavourable, and weigh at the time when it is found the flood tide trends round to windward, as the tides revolve round the compass with the principal tendency of the current to the westward. *See* 376 to 382.

366. **December.**—This month is so much like the latter part of the last as regards its winds and weather, that little remains to be said concerning it. The temperature has grown cool, as the sun, and with it the south-west monsoon, has receded across the equator: and on the whole, this month is free of any disturbance at the head of the Bay, from which part, however, cyclonic disturbances far south are often seen aloft in the sky.

There is generally a little rain about Christmas, which seems to work down from the northward, and during which time it blows fresh from N. and N.N.E. As in November, this winter or north-east monsoon flags, as the land is heated during the day and veers to the eastward and S.E., dies away, and freshens again as it cools down by night. December is indeed the finest month of all the twelve, and the sea is most tranquil, with scarcely a ripple or sign of any swell at the Pilot Station.

The Intermediate Light is removed on the 1st of this month, during which time the Lower Gasper Light Vessel burns a blue light every hour instead of at the hours.

For making the Pilot Station, see November. Also *see* 376 to 382.

367. **January.**—For the Sandheads, the north-east or winter monsoon may be considered as finished at the close of this month; for then light westerly and south-westerly airs and calms predominate, and with the taking off of the northerly winds the air grows a little warmer. I have run a vessel to Calcutta with a fresh southerly wind in January: but, if southerly winds set in strong, they are generally stifled by a light north-west squall or a northerly wind and fog bank, or rain even, before long.

These southerly airs in the evening, as a rule, produce thick fogs in the river in the morning, which often roll their fleecy banks down even as far as the Pilot Station, when very heavy. I have seen a fog last till 11 A.M. during this month and the next.

This southerly or south-westerly wind is simply a convection current, above which, as Mr. Blanford tells us, the N.E. or winter monsoon is still blowing and impinging on the sea surface a short distance seawards, returning in part as the surface current, and blows in full vigour now down in the southern part of the Bay.

For Baric Pressure, Sea-set, &c., see 376 to 382, and for making the Pilot Station, see November.

368. **February** may be said to usher in the dry and hot season of the S.W. or summer monsoon; when, as Maury tells us, the two winds are in equal conflict between the parallels of 20° and 22° N., and the south-west winds begin to work their way down the Bay at the rate of fifteen or twenty miles a day. The winds are mostly from S.W. to N.W., with now and then a spurt of northerly winds, or, perhaps, a north-wester; but, except on one or two occasions, which may be termed extraordinary, these north-westers are not very violent in this month. Fogs are also very prevalent in the river; now the sea breezes have begun to attain to some strength (a southerly breeze in the evening is always a precursor of a fog the next morning), especially about sunrise, some of them lasting up to noon and rolling away down to the Pilot Station. But the weather in the Bay is very fine and the sea smooth. Towards the latter part of the month these winds begin to get stronger and haul more southerly, and the flood tides in the river begin to run as strong as the ebbs.

Syvret's Sailing Directions (now out of print) tells us, truly:—

"In February, generally light variable winds prevail, and a great deal of calm weather, sometimes a spurt of wind from the northward, but it does not last; in the

night there is generally a light southerly breeze, with a fog in the morning. The fogs are very heavy this month, frequently not clearing up till past 8 o'clock in the morning. It sometimes happens we have strong southerly winds in the middle or latter part of this month, the weather having the appearance of the S.W. monsoon, which lasts for three or four days, after which calms or light winds may be expected. The strong floods commence to be felt in the river towards the latter part of this month, but on the whole the weather is fine; north-westers sometimes make their appearance after a southerly breeze, but are not so strong as in March and April; the weather begins to get warm also."

Hockford tells us in his directory that in February "the winds in the Long. of 88°, or to the westward, are favourable for getting to the northward."

For other information, *see* Wind Tables, 376 and 377; Pressure Table, 380, &c., &c., Also Set of the Sea-currents Table, 379.

North-Westers.—In writing about these storms, I cannot do better than quote from Mr. Blanford's Indian Meteorologist's Vade Mecum, which gives their true explanation, and which will, I feel sure, be of interest and advantage to shipmasters who have not yet possessed themselves of that most valuable book to all who sail these waters.

Page 231, para. 129, North-Westers:—"The dust-storms already described differ in some important respects from the north-westers of the Lower Provinces, and, indeed, other parts of India, which are akin to the summer storms common in Europe, but generally more violent. These latter occur chiefly in the months of March, April, and May, when the sea wind, which carries vapour some hundreds of miles into the interior, is met by the dry westerly winds described in § 93, and it is in the region of ascending currents between these two winds that north-westers originate. The name is taken from the fact that, if they move, they always advance seaward,—that is, driven by the land wind, which blows (from the west or north-west in Northern India) above the stratum of the cumulus clouds, even though the sea wind may be blowing below almost up to the time that the storm bursts."

I may here note that this wind often sends out a mantle of cloud over the strengthening south-west surface wind at the Sandheads for an hour, more or less, before the storm bursts, or, as I gather from Mr. Blanford's description of it, before the atmosphere near the sea surface is suddenly turned upside-down, if I may be allowed the expression.

"From Calcutta" (and also from the Sandheads) "throughout the months abovementioned, a low bank of clouds is almost always visible to the west and north-west in the afternoon; and on the approach of a north-wester this rises higher and higher; a sheet of pallio-cirrus, frequently with a hard, straight edge advancing before the lower mass of the pallio-cumulus. At other times a sheet of cirro-stratus forms over the greater part of the sky early in the afternoon, becomes thicker as the day advances, and at last a heavy mass of pallio-cumulus forms beneath it and completes the storm-cloud, and always either seaward or at least from some point between east and round by north to south-west. I do not remember to have ever observed a storm advance from the direction of the sea. The wind that precedes the rain is very cool; I have seen the thermometer sink 20° in the space of ten minutes on its approach. It raises clouds of dust and blows in gusts, sometimes with great force.* Pressures of 50 lbs to the square foot have been sometimes registered by it on the Osler's Pressure Gauge at the Surveyor-General's Office; and on one occasion, the first and fiercest of these storms that I ever witnessed, *viz.*, on the 14th May, 1858, the Calcutta Race-stand was blown down, and for upwards of a quarter of an hour the wind had the force of a severe gale; during the whole time the air was so thick with dust, that objects could not be distinguished even at a few yards distance. On this occasion a large quantity of hail fell.

"The storm-cloud is probably in all cases the seat of an ascending convection current; and occasionally, the course of the in-flowing currents is rendered visible by small tufts

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*** As noticed at page 185, Mr. Eliot tells us that at Calcutta in a recent nor'-wester the wind-gauge showed a pressure of 55 lbs to the square foot, which gives a theoretical velocity of 115 miles per hour.**

of cloud, which form in the transparent atmosphere beyond the edges of the storm-cloud and drift up into it, when their horizontal motion ceases and they become absorbed. The pallio-cumulus is always in a state of great internal disturbance; and, after the first onset, it either does not advance further, or its advance is very slow. Frequently, in one of these storms, the wind and the movement of the clouds change, during the storm, through many points of the compass. At other times the wind almost ceases when the rain falls. On one occasion in Calcutta, a north-wester which occurred about nine in the evening was followed by a hot wind from the west, which sent up the thermometer several degrees."

The above account of north-westers accords with their onslaught at the Sandheads, and I think it will be acceptable to the earnest seeker after truth if I here give also a quotation from Mr. J. Eliot's Paper on Storms in Bengal, &c., &c.:—

"The only apparently possible explanation of the phenomena of this class of storms preceded by the unusual feature of a rise in the barometer, seems to be that already advanced in the discussion of the storm of June 5th, 1876,—*viz.*, that, from more or less unknown causes, there is a defect, or a tendency to a defect, of pressure in the lower atmospheric strata; over or near the storm region; and that from the relative distribution of pressure, vertically as well as horizontally, and in the neighborhood of the storm region, the motion which ensues towards the region of diminished or diminishing pressure is not solely horizontal, but is due to the descent of a mass of air, from a higher stratum to the surface, in a more or less slanting direction. The increase of pressure, before the actual arrival of the moving mass of air and the commencement of the storm, would, on this supposition, be due to what is usually termed dynamic pressure, produced by the resistance either of the lower strata in a state of rest or of much slower velocity; or of the earth to the downward motion of the mass descending towards it."

The sudden burst of the storm can only be explained by assuming that "the atmosphere is a viscous gas," and (to use a recent statement of Sir George Biddel Airy), "it is only on this assumption that cyclonic phenomena and the

phenomena of all rotatory storms in the hotter parts of the earth can be explained, and that in such storms there is a mass of hot air which, from the viscosity of its structure, is not able to rise up for a long time, until at last it rises up with a burst." Some of the phenomena of north-westers and of dust-storms in Upper India are apparently only explicable on the assumption of the viscosity of the atmosphere.

The barometer, as has been already stated, rises steadily, until the first onset of the storm, when it falls for some minutes, and afterwards oscillates in such a way as to indicate that the small rapid variations which occur depend mainly, if not entirely, on the variation in the wind velocity. The fall of the barometer, coincidently with the sudden increase of the wind velocity, is in accordance with hydro-mechanical principle, that "the pressure of a gas under the same conditions of temperature and density diminishes with an increase of its velocity." "In all cases, the barometer begins to fall with the commencement of the violent wind; and its oscillations, so far as can yet be judged, seem to depend chiefly, if not entirely, upon the changes in the strength of the wind, an increase of velocity accompanying a fall, and a decrease of velocity, a rise of the barometer." * * * * "Other north-westers that have been examined, seem to confirm strongly this dependence of the variations of the air pressure upon the wind velocity during the prevalence of the storm."*

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* The following from a paper by H. F. Blanford, Esq., F. R. S., read before the Members of the Asiatic Society on the 6th April, 1880, will be useful here:—The second subject discussed was the variations in the density of the lower and higher strata of the atmosphere, as shown by a comparison of the barometric pressures at hill-stations with those on the plains. It was shown that in many cases the density of the lower strata of atmosphere was below the average, when the barometric pressure as a whole was in excess of the average, and *vice versâ*, indicating that the higher strata must have an naomaly of the opposite character to that of the lower. It was also shown that a similar opposition of conditions is of annual recurrence at the setting in of the rains. It was proved in the former part of the paper, that the action of cloud and rain was to lower the temperature of the lower strata of the atmosphere; their effect on the higher strata would probably be of the opposite character, which would explain and reconcile the apparent barometric anomaly in question.

And, again quoting from Mr. Blanford's Indian Meteorologist's Vade Mecum, "on Hailstorms," page 233, this gentleman goes on to say:—

"The general conclusion that may be drawn from these data is, that hailstorms are generated at the meeting of a very dry wind with a damp wind. The Gangetic Delta in the months of February, March, and April is by no means a characteristically humid tract, comparable with the Malabar Coast of India; but is the place of meeting between the dry land winds of the interior and the more humid winds from the sea, and, at a certain moderate altitude, the land wind blows outwards to the south-east during the whole of the afternoon; while the sea wind may prevail for two thousand feet above the land surface."

During these three months, and also in May, the atmosphere at the sea surface at the Sandheads gradually becomes very damp, and, in the latter month, becomes so damp that the decks will scarcely dry: also the atmosphere below is filled with a yellow haze, whilst the wind may have the strength of half a gale from S.S.W. or S.W. It is on such days, when day after day, the air has become, as it were, surcharged with this moisture, that a nor'-wester comes and clears it away; and the first is generally repeated for two or three successive days, at about the same hour, at a time when the atmosphere is cooling most rapidly, say, from 4 to 8 P.M. The barometer gives no indication whatever of their approach, in fact, at the first onset, the glass rises by a jump of sometimes over a tenth, and then gradually falls to its normal height again. They are not rare in the morning either; and in February, 1876, a very heavy one burst suddenly over the river and Sandheads at 9 or 10 A.M., and actually took the main mast out of a ship at anchor at Diamond Harbour, in one of the whirling eddies which swept down upon her.

The very rapid condensation into cloud and rain or hail, as the damp sea wind whirls away aloft in a nor'-wester and the friction of the watery vesicles and rain drops against the air developes and gives forth copious discharges

of electricity, and often the sky above is quite aglow with displays of lightning, chain and forked, dashing to the earth or sea surface, ricocheting amongst the writhing cloud masses, or bursting into thousands of fiery serpent-like arrows shooting all round from some one point in the zenith, and followed, in some cases almost simultaneously, by the terrific crashing roar of the thunder peals. So that (especially with a cloudy sky on a moonlight night) it behoves the careful navigator of this part of the Bay to watch carefully to the N.W. for a flash of lightning, or a suspicious streak of white fleecy cloud near the horizon in that direction; and, on seeing the first flash, he should take in sail and get the ship on the starboard tack, so as not to be taken aback by the shift of wind from S.W. to N.W. which comes after the short interval of one or two minutes of cold calm. I would advise the topsails to be lowered, and the helm to be put up on the storm bursting, and to run before it till one can see what it is going to be; for no one yet had been able to judge of their strength,—a perfectly formed one, that is, one with a well defined arch, which a flash of lightning may have disclosed, turning out sometimes not to be the strongest, as those well-formed ones generally are.

I have seen a pilot vessel running for 4 or 5 hours in one, in a heavy N.N.W. gale, during which the sea fell on board so as to compel the hatches to be put on. On board the brigs we always stow all sails, except the hoisted foretop-mast staysail, to assist to keep her before the wind, so treacherous are they in their appearance when bearing down on the vessel. And a vessel can always run back again in the southerly wind which springs up soon after they are past. Sometimes these nor'-westers commence at N. or N.E., but this is rare; yet they usually veer round to N.E. and finish off with the wind from the eastward.

In February at Saugor Island, 38 per cent of the winds are from S. 54° W., and the mean diurnal movement 192·5 miles.

The Intermediate Light is placed in position on the 1st of this month, when the Lower Gasper Light Vessel discontinues burning the extra blue light at the whole hours.

See Lower Gasper Light Vessel, 166. Also see Wind Tables, Baric Tables, &c., &c., 376 to 382.

369. **March.**—This month is much the same as the last, except that the southerly winds have now fairly set in with warm weather, and an occasional nor'-wester in the evening, and they blow very hard in this month and the next. As the winds are gradually extending out to sea farther and farther, so the swell is increasing, and therefore the pilot brigs are now more underweigh than at anchor.

The tides in the river are stronger than at any other period of the year, and they bring bores on the perigee springs.

The Ridge Light is placed in position on the 15th of this month, and the Eastern Channel Light burns a blue light every alternate half hour of the night from this date.

The winds round the head of the Bay are, as in last month, anti-cyclonic,—that is, as Heckford in his Sailing Direction tells us, "in standing to the E.S.E. with a vessel, the wind will veer from S.W. to West, N.W. and N.N.W. and North;" and Mr. Blanford in his Vade Mecum, at page 181, tells us :—

"Little by little, these winds are drawn from a greater distance at sea; and, more especially in the north-east corner of the Bay, these south-west winds blow with great force in the month of March, sometimes rising to a gale. In this month the relations of pressure over the Bay are precisely the reverse of those of October. It is the seat of the highest pressure; and the tendency of the winds is, on the whole, anti-cyclonic. At Port Blair, 59 per cent of the winds are from south-west, and at Akyab 56 per cent from west, north-west or north."

So that ships do well to keep on the western side of the Bay when bound to the Hooghly, as we read in Heckford's valuable little book :—"It is advisable to get to the westward, especially from Moulmein to the southward of Lat.

15 N., and after passing the Preparis Island on no account tack if you make a W.S.W. course, but stand to the westward; and on getting the first light southerly breeze, which prevails in 89° and 90° east, do not steer a direct course, but steer to the westward or W.N.W., and the southerly wind will strengthen. You may then edge gradually away for the Sandheads, keeping to the westward of the meridian of the Floating Light to check the strong easterly current that prevails in the northern part of the track in all this month."

Maury tells us in his Physical Geography of the Sea:—

"That the north-east winds have been 'backed down' as far as the parallel of 15°—the medial line between them from which each monsoon is blowing;—and, where again, the conflict of 'back to back' equally divided takes place as to time of mastery (12 days) on either side."

This medial line is a ridge of high baric pressure, which is also explained in Blanford's Indian Meteorologist's Vade Mecum at page 176, where he says:—

"In February and March the pressure falls about 0·2 or 0·3 over the land, but to a much less extent over the Bay of Bengal; and in the latter month, it is, as a rule, higher over the middle of the Bay than either over India or the equatorial sea to the south."

(See Table of Barometric Pressure, 389, &c., for further information.)

By the end of the month the south south-west winds have become quite strong, but still we have fine dry weather, except the now frequent N.W. squalls, and the damp yellowish haze which has become such a fog, that ships approach to within half a mile sometimes, on the latter part of the day, without being seen. Therefore good use should be made of the lead and the dead reckoning attended to, as a bad horizon almost precludes the idea of a sight for longitude; and as the light vessels are painted of a light and yellowish colour, they are not very easily picked up. And beware of right or easterly deviation of the compass when running N.E. by E. (see 168), if your magnets or compass correction are the same as they were placed for adjusting the compass in England.

The brigs now, in the S.W. monsoon, cruise about at a distance of 5 to 8 miles S.S.E. to S.W. of the Eastern Channel Light night and day (see Pilot Station, 361).

I may here quote Mr. Blanford in his "Winds of Northern India." At page 19 he says:—

"At Saugor Island the sea wind sets in in February, somewhat suddenly, from south-west by south, and during the hot weather months backs gradually through four points of the compass, increasing in steadiness and mean velocity till the setting in of the rains in June."

And at page 44 of the same paper, when referring to the spring rains, Mr. Blanford says:—

"The spring or hot weather rains prevail over all that region over which sea winds set in from the Bay of Bengal at an early period of the year. In Assam and Eastern Bengal showers are pretty frequent in March, or even February, and in April the rainfall is pretty general and copious. * * * * In the western part of the delta it amounts to between 2 and 3 inches (except on the coast line, where it is heavier). These rains are felt as occasional thunder-storms, known as north-westers, as far inland as Nagpore, and also in Behar and the western half of the delta much is received in this form."

Also at page 63 of the same paper, we read the very useful and instructive account of the phenomenon of the south-west monsoon, its causes and effects, as follows:—

"The south-west monsoon is produced by the heating of the land surface of the Peninsula and the superincumbent air to a temperature much above that of the sea to the southward. Six weeks before the vernal equinox sea winds begin to set in in the lowest stratum of the atmosphere, on the maritime belt of Lower Bengal and Orissa, and gradually advance further and further inland. At the same time over the whole of Northern India the winds continue to blow from the westward, rising gradually in temperature, and at length blowing only or chiefly in the day time as the hot winds of April and May. This state of things depends probably on the high temperature being restricted to the stratum of air immediately over the ground. But with the advance of the sea winds and the upward diffusion and condensation of their vapour, the heat also is diffused to higher levels. In May, the rise of

temperature at 7,000 and 8,000 feet proceeds as rapidly as on the plains, or even somewhat more so. By this diffusion of heat and the increasing temperature of the ground surface and the lower strata of the air, under a nearly vertical sun, the pressure falls steadily, and the sea winds are drawn from a greater distance south. At length, as seems probable, in June, the ridge of high pressure over the sea, which has steadily receded southwards since February, is obliterated, and the south-east trade, or perhaps only a portion of it, crossing the line brings the monsoon rains to Bengal and the west coast of India."

(Here reference is made to Maury's Physical Geography, and to Meldrum's British Association Report, 1867.)

"These south-west winds 'back down' more rapidly on the western coast of the Bay than they do on the Arakan coast, as is stated at page 25 of the same paper; 'thus at Madras, in Lat. 12° N., southerly winds predominate in March; whereas at Akyab, in Lat. 20° N., they do not gain the upper hand until the month of May.' A section of the atmosphere from Upper Assam to the Bay near the Arakan shore in the Lat. of Akyab, would probably in the month of March present a system of currents resembling the accompanying diagram."

And there is no doubt, as Mr. Blanford says, this south-west wind before the rains set in, is confined to but a thin surface stratum: and immediately above it, the opposite current is made visible by the tops of the low fracto-cumulus cloudlets or tufts drifting so rapidly along in the strong south-west surface wind being torn off and dragged back to the southward, as they get entangled in that current, and this especially so just about the time when a north-wester may be looked for to clear the air of the haze, when it would appear as if the yet invisible N.W. wind blowing over these two lower currents, presses the north-

east or anti-monsoon current down upon the surface wind, and, possibly, attempting to circulate with it as the surface wind. It may be that the formation of these little tufts of scud is the result of the close contact of the cool upper current with the lower humid one. These tufts are always more plentiful towards the latter part of the day, say, about 3 P.M., when the wind generally blows hardest, and are more southerly than at any other part of the day. It is well known to pilots that the S.W. monsoon winds are always more westerly at the Sandheads in the morning.

In the rains, the time of greatest rainfall and heaviest squalls is from 4 to 7 A.M., the weather generally clearing up by 10 or 11 A.M. At Calcutta, the hour of average greatest rainfall is at 1 P.M.

In March, at Saugor Island, 62 per cent. of the winds are S. 40° W., and mean diurnal movement, 231·4 miles.

370. **April**, at the Sandheads, is much the same with regard to the force of the wind and the weather, as March, except that the general direction of the winds have become much more southerly, in fact they may be said to blow from south. There are, as during the last month, occasional lulls in the strength of the monsoon, with light winds and calms: but towards the end of the month, this and May being the spring transition period, cyclones sometimes form and blow with some force, which, like the heavier ones at the autumnal period—October—are heralded by N.E. winds and squally weather (after the preliminary spell of hot, calm, and sultry weather), and also by the the S.E. bank of clouds and swell. This swell travels a long distance as instanced in one which I know sent in its swell, and showed the S.E. and southerly bank, with its fringe of cirri-cumulu travelling up from S.W. (against the N.E. surface wind), even right up to the Pilot Station, from Lat. 15° 49′ N., Long. 87° 14′ E., on the 24th, 25th, and 26th of February, 1870; as the "C.N.," in the above position, experienced a heavy cyclone on the 25th, which began with the wind at east, veering by S.E., S., and S.W. And it thus appears

that cyclones are liable down the Bay at all seasons of the year.

The haze also is very dense on the water during this month as in the last one, except immediately after a nor'-wester; and the air is warm, but very damp, night and day, although it is far cooler than above Saugor; in fact, in this, or in the hottest month of the twelve—May, as long as there is any wind the temperature seldom rises above 86, or 88 in the shade, but it rises to 90 or 92 as soon as the wind dies away.

The north-westers are now in full swing, and their coloured heads begin to loom out above the haze in the N.W. as the day advances, or mushroom-shaped, or out-spreading fan-shaped cloud curtains are thrown out in advance early in the afternoon or evening, say, after 3 P.M.; and as the clouds aloft grow denser, the tufts or shreds of scud hurrying along in long low-lands seem gradually to be stayed in their course when they arrive under the cloud screen, and even to move slowly against the surface wind for some time before the storm grows dark and bursts. As in the last two months, the N.W. current, high up, is often indicated by rippled golden coloured cirri or cirricumuli.

The swell is at times running high, so that there is danger of anchoring at the Sandheads: and as the winds blow strong, it is to be supposed that vessels will have a good suit of sails bent to stand it when the vessel has to be put on a wind, or to contend against a south-east gale with its attendant W.S.W. set of perhaps 3 knots.

From the middle of last month vessels should now, if the winds are not easterly, make the coast at the Black Pagoda and sight False Point, which has a new fixed light upon it visible at 19 miles in clear weather;* and then run up N.E. by E. along the south-eastern edge of the Pilot's Ridge (328), keeping in between 20 and 27 fathoms, and try to pick up the Ridge Light (312); shaping a course

* Captain Geary, the master of the "Zanetta," told me he saw it from his bridge 20 miles off.

from thence 32 miles E.N.E. for the Eastern Channel Light and the Pilot Station (361): and keep the lead going, and the log hove, so as not to get into shoaler water than 12 to 14 fathoms, and also, not to be swept too far out by the ebb tide, and so miss and run past the pilot vessel and the Eastern Channel Light. Off the tails of all the sands west from Saugor Sand (inclusive), in from 15 fathoms to less, the soundings are more or less sand with mud and full of the glistening particles like bright 'steel filings,' which seem to be small pearly flakes or scales of shells.

When making for the Eastern Channel after a breeze, and there is a probability of buoys and lights being out of position :—After making the clear soundings of the head of the Pilot's Ridge, run north to 17 fathoms yellow clay and stones, then stand east, and the soundings will shoal suddenly from 15 to 8 or 9 on the tail of the Western Sea Reef, then deepen in the South Channel to 11 or 12 fathoms, and shoal again on the tail of the Eastern Sea Reef to perhaps 7 fathoms. Be careful to allow for the set* of the tides, a spring flood setting a vessel strong on to the tails of the sands, where the swell runs high; and, on the other hand, a spring ebb may set the vessel outside the line of soundings, when the lead cannot feel the hard tails of the Reefs, nor will the water shoal on them. After a heavy breeze the pilot vessels usually adopt this plan of making the Station.

371. **May** is like the end of April in its weather and winds; the wind direction being, on the average, between South and S.S.W., veering more to the westward, as it does all through the S.W. or summer monsoon, during the first early 8 or 10 hours of the day, and hauling back to the southward again as the land gets heated in the afternoon. The southerly swell at times is

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* For Tables of Mean Baric Pressure, &c., Wind Tables, Tidal Set, &c., &c., see 360, 376, 379, & 380.

now very heavy, as the winds have extended their range down the Bay; and the air is very damp, so that the decks scarcely dry during the day: yet in this month this very same vapour-charged wind arrives at Calcutta dry and parching at the ground surface, but still carrying along with it some of the yellow haze with which it is laden as it travels over the sea at the Sandheads.*

May, like the last month, being included in the spring transition period, cyclones may be looked for, the prognostics of which have already been discussed: but northwesters are not so common now that the monsoon current has grown thicker, and the vertical distribution of temperature has, in consequence, become more natural and regular; and therefore the surface stratum of vapour-charged air is not so liable to that subversion of vertical equilibrium which, Mr. Blanford tells us in his paper "On the Diurnal Variation of Rainfall frequency at Calcutta, 1879," is really the whole phenomenon of these storms.

Mr. Eliot in his Report on the Madras Cyclone of May, 1877, at page 6, says of the April transition period:—

"Along the greater part of the coast there are land and sea breezes during the day, and hence the directions vary considerably. The mean direction along the Malabar Coast is from west to north-west. Around the coast of the Bay of Bengal the mean direction of the winds ranges from south-east on the Coromandel Coast, to south south-west at the head of the Bay, and west at Akyab and Moulmein. * * * * * * * * Over the centre and east of the Bay the winds are very light and variable in direction, whilst in the south they are from the north-east. The winds round the Bay (an area of relatively high pressure) are thus anti-cyclonic in character. The intensity

* It would seem that this haze is caused by the fine dust particles or haze from over the heated land of the far interior, carried up and out over the sea by that upper return convection current, which Mr. Blanford so well sets before us in his diagrams; and it is well known that dust (the finer the better) favours the production of fog. I have sometimes seen this haze so thick that ships under sail have approached to within half a mile before they have been visible, and this at mid-day.

of the winds is at this time greatest on the northern and eastern coast of the Bay, and lightest at the entrance."

Heckford's Sailing Directions for the Bay of Bengal, &c., tells us of May,—

"The winds and currents well towards the coast are favorable for making a quick passage up the Bay. They are mostly from the south and south-westward to the northward of the 19 North and to the westward of 92 East." * * *

Bad weather is sometimes (though rarely) experienced in this month.

Mr. Eliot in his Report on the Madras Cyclone of May, 1877, at page 5, tells us that—

"During the month of April, with the continuation of the diminution of pressure, the ridge or belt of high pressure retreats southward, oscillating backwards and forwards during the change, and also diminishing in amount with respect to the pressure at and near the entrance to the Bay —a region of almost uniform and permanent low pressure. By the continuation of this gradual process, the belt of high pressure—relative to Northern India—usually at the end of April or the beginning of May, merges into the belt of permanent low pressure (relative to the region to the north) near the entrance to the Bay and over the equator; thus establishing a continuous baric gradient from the Tropic of Capricorn to the north of India, determining the steady flow of a strong moisture current from the Indian Ocean and its arms, the Bay of Bengal and the Arabian Sea. The establishment of this non-local current immediately precedes the setting in of the rains, which usually commence in Ceylon between the 14th and 20th of May, at the Andamans and Rangoon a few days later, and at the head of the Bay during the first or second week of June."

And from the same report we learn,—

"The chief peculiarities of the meteorology of the Indian area during the April transition period of 1877 immediately preceding the Madras Cyclone of the 18th and 19th of May of that year may be briefly recapitulated as follows:—

"*1st.*—Increased pressure over the whole of Northern India from Bengal westwards to the Punjab, and also to a less extent over the Bay of Bengal.

"*2nd.*—Diminished temperature over the greater portion of this area, the defect being greatest in the North-Western Provinces and probably the Punjab. On the other hand, the temperature was in excess over the south-east of the Bay, and was normal on the opposite or south-west coast of the Bay, including Ceylon.

"*3rd.*—Diminished wind velocity over the whole Indian area, and more especially in the Gangetic valley, partly due to the comparative weakness of the day and sea winds, consequent on the diminished temperature of the land area and increased temperature of the sea area, and partly to the unusually small baric gradients."

And another paragraph from the same instructive report in connection with the rapid oscillations of baric pressure in north-westers is worth quoting here:—

"The fall described in the previous day was followed by a very considerable rise of the barometer over the whole of India and the Bay during the succeeding twenty-four hours. Those rapid oscillations of pressure over large areas like the Indian area with which we are dealing cannot be due to actual influx and efflux of the air, but are probably solely dependant upon variations of the temperature, density, and velocity of the strata nearest the earth's surface, and are necessarily connected with the expansive action of the solar heat on the atmosphere."

And also from the same authority: On the intermittent character of baric pressure in cyclones, we read:—

"The wind and rain squalls, most intense and persistent near the central area of convergence, are essentially discontinuous in character. The barometer oscillates through as much as the tenth of an inch during each squall. The wind veers and backs through four and six points in as many minutes. The facsimile copy of the trace of the anemograph taken during the Calcutta Cyclone of 1864, given in the report on that cyclone, shows in the clearest manner the rapid variations of the direction and intensity of the wind during a cyclone. The same features distinguish minor cyclonic disturbances in Bengal and the Bay of Bengal. The wind always occurs in intense gusts, followed by intervals of partial calm. * * * If the motion is due to the continuous action arising from differences of pressure over large areas, which necessarily increase or

diminish slowly and gradually, it ought apparently to give a continuous and not an intermittent result. The wind-motion, however, like the rainfall, is essentially intermittent and discontinuous in character, and the suddenness of the occurrence of the gusts is paralleled only by the equal suddenness with which the rain is precipitated."

It is this unsteadiness in the wind direction which so tries the sails, and shakes them to ribbons before the ship can be got out of the wind.

Heckford's Sailing Directions tells us of this month:—

"This is a treacherous month and not to be relied on, west to southwest winds prevail mostly, and liable to changes. * * * If a steady monsoon is blowing, the chances are that you will have no bad weather. But light airs and sultry weather with lightning is, generally speaking, the precursor of a breeze."

Blanford's Vade Mecum, at page 255, tells us:—

"However strongly the winds blow on the shores of Bengal and in Orissa, if they are from south, with any westing in them, there is no fear of a cyclone."

Also:—"Calm, close weather in May, June, and October, on the Bay and its coasts is always treacherous; and an unsteady summer monsoon in Bengal is always ominous of storms."

For making the Eastern Channel Light Vessel and Pilot Station, see directions for April, and for Baric Pressure, Wind, &c., see tables at pages 360, 376, 379, and 380. Also, see what is said in the three preceding and the following months; and what has been said about cyclones in chapter for October.

372. **June.**—Maury in his Physical Geography of the Sea tells us at page 368, that "it is June before the south-west monsoons have backed down as far as the equator and have regularly set in there:" also, at the next page,—"By the month of June they (the south-west) have fairly gained the ascendency, and so remain masters of the field until October, when the bi-annual conflict is again commenced at the north."

From Mr. Blanford's "Winds of Northern India," we read:

"At Cuttack and False Point we meet with a wind system

very different in its more striking features from any yet described. The land winds from north and north-west are here quite of subordinate importance, and a great predominance of those from south-west and south blowing along the shore, or obliquely from the Bay towards the hilly country of the interior, characterizes Orissa and the Northern Sircars. At both the above stations, winds from between north and north-east set in as early as October, and with the increasing cold of the interior and strengthening of the land winds, they become more northerly in the two following months. At False Point indeed they maintain a marked ascendency till the end of January, veering back, however, towards north-east and east; but at Cuttack the veering proceeds further, and sea winds from east and south-east predominate in this month (January).

"In February south-west winds gain the ascendant at False Point, and south winds at Cuttack, a difference of about four points between the two stations being maintained throughout the hot weather and rainy months. With the increase of temperature in the interior, south winds at Cuttack and south-west winds at False Point increase in steadiness, backing through one or two points up to May. In June, with the setting in of the rains in Bengal, the veering again becomes normal, and this tendency is maintained till the month of August. In September, the south-west monsoon slackens, and the wind once more backs through south and east to north-east in the month of October. At False Point, as at most coast stations, calms are of rare occurrence. In October, the month of their greatest frequency, they amount to only 11 per cent. of the observations, while in May none are recorded. They are somewhat more frequent in the cold weather than the rains, and least so in the hot weather months" (February to May). "This appears to be an universal rule in Northern India. * * * *

"At Saugor Island, south and south-west winds predominate greatly over those from all other quarters, amounting together to 52 per cent. on the average of the year. North-west and west winds and their opposites are least common, amounting from 5 to 8 per cent. respectively. * * * *

"The winter monsoon or land wind sets in in October, and becomes well established in November, with a mean direction, which is nearly north at Dacca and Saugor

Island, north north-west at Calcutta, and north-west by north at Berhampore. At Saugor Island, it blows pretty steadily during the three months, November to January, from a direction a few degrees east of north. * * *

"At Saugor Island, the sea wind sets in in February, somewhat suddenly, from south-west by south, and during the hot weather months backs gradually through four points of the compass, increasing in steadiness and mean velocity till the setting in of the rains in June. At Calcutta, Berhampore, and Dacca, a similar change in direction occurs, but through a greater range. Thus at Calcutta the wind backs through eight points, at Dacca through nine, and at Berhampore through ten points between February and May.

"On the setting in of the rains, the wind veers normally (to the westward) about half a point or a point—a change small in amount, but equally distinct in all parts of the delta in the ten-year table of Calcutta, and the three-year table of the other stations. In the following months, however, the winds again acquire more easting, until in September, the last month of the rains, the mean directions are S. 4° E. at Saugor Point, S. 30° E. at Calcutta, and S. 70° E. at Berhampore. At Dacca and Saugor Island, that incursion of westerly winds in August, which is so marked at Hazareebagh and other stations already noticed, is distinct, though less striking, and it is traceable even in the Calcutta table. At the two first-named stations there is a temporary increase of south, south-west, and west winds in August, and a corresponding decrease of south-east winds, such as to cause a normal veering of the resultant through nearly two points at Dacca and one at Saugor Island. At Calcutta and Berhampore this does not take place, but the backing of the wind is somewhat less between July and August than either in the preceding or following months.

"In October, the winds are mostly from the east, but unsteady and stormy, alternating with calms in the earlier part of the month, and northerly or north-westerly in the latter part. * * *

"In all parts of the delta the velocity of the wind is lowest in November and highest in May and June. This difference is greatest at the inland stations, Dacca and Berhampore. * * * At all times of the year the velocity of the wind decreases rapidly from the coast line. Thus

at Saugor Island, Calcutta, and Berhampore, the mean diurnal movement of the wind in May and November is as follows:—

	May.		November.
Saugor Island ...	345 miles	...	111 miles.
Calcutta ...	209 „	...	82 „
Berhampore ...	106 „	...	29 „

"At Chittagong, there is no very decided preponderance of any one wind direction on the average of the year, but north-west winds are less common than others, and, on the whole, southerly winds are in excess of northerly in the proportion of 42·5 to 30 per cent. As in the Gangetic delta, the annual rotation is retrograde from November to the following September; in this case through more than two-thirds of the compass: and the change from the characteristic direction of the summer to the winter monsoon takes place somewhat abruptly in the month of October. In the cold weather months the average direction is from between north and north-west, but less westerly by about a point than at Dacca (140 miles to the north-west); northerly elements preponderate till the end of February,—that is to say, a month later than either at Dacca or Saugor Island. Between February and June the wind works round gradually to the southward, and in the latter month it backs further to about south-east by south, which is its average direction as long as the south-west monsoon prevails over the Bay. At all times of the year the mean direction is modified by land and sea breezes. The average velocity is more uniform than at inland stations. When greatest, *viz.*, in June, it is less than twice as great as its minimum in October or November. At the former period it is less than at Dacca, at the latter nearly three times as great. At these two stations the periods of maximum and minimum are approximately the same, and about a month later than at most stations to the westward. Calms are not very common at any time of year, and occur chiefly at the close of the south-west monsoon.

"The wind system of Akyab differs from that of Chittagong in much the same way as the latter differs from that of Dacca, *i.e.*, the corresponding phases of the wind's rotation occur about six weeks or two months later at the more southerly station; and while the average direction of the summer monsoon is less easterly, that of the winter monsoon is less westerly. Thus, at Akyab, northerly

elements preponderate over southerly in April, and southerly over northerly in October, the reverse of the case at Chittagong; in other words, both monsoons continue to be felt on the coast of Akyab one or two months after the change has occurred at Chittagong. This accords with the results of Captain Maury's discussion of ship observations in the Bay of Bengal" (see Maury's table of the March of the Monsoon Winds between Calcutta and the equator at 376; also Lieutenant Cornelissen's table at 377), "and is also what may be anticipated from the character of the barometric changes presently to be discussed."

Also see what is said in the same paper (Mr. Blanford's "Winds of Northern India") in the chapter on March.

Here is an instructive paragraph from Maury's Physical Geography of the Sea, fourteenth edition, at page 374, "The changing of the Monsoons:"—

"It is these calm belts or 'medial lines,' as the crest or trough of the barometric wave may be called, which, with the canopy of clouds, follow the departing, and herald the coming, monsoon. They move to and fro, up and down the earth, like the sun in declination. As they have a breadth of 200 or 300 miles, they occupy several days in passing any given parallel, and while they overshadow it, then the monsoons are dethroned. During the interregnum, which lasts a week or two, the fiends of the storm hold their terrific sway in these lands. The changing of the monsoons is marked by storm and tempest. Becalmed in them, moanings are said by seamen to be heard in the air—a sign of the coming storm—a warning of impending danger to ship and crew, then the props and stays are taken away from the air, and the wind seems ready to rush violently hither and thither, and whenever there is from any cause a momentary disturbance of the equilibrium. In such an atmosphere, the latent heat that is liberated by heavy rain showers has power to brew a storm. Throughout the monsoon region, the people know beforehand, almost to a day, the coming of this interregnum, which they call the changing of the monsoons, for their annual change at the same place is very regular."

The above is a very good account of the changing of the monsoons on the Malabar Coast and down in the southernmost parts of the Bay, but here the change is not attended

with such violent outbursts as above described, unless a cyclone brews up in May or June. As June comes in, the winds from S.S.W. and South seem to be checked in strength, and gradually veer to the westward, say S.W., the sky then begins to show changes; long streaks of cirri—cu like mares' tails cross and recross each other from S.E. to N.W., and from N.E. to S.W., and the sky gradually clouds over, with towering cumulus here and there; and there may be seen strong winds aloft from the N.W., as shown by the drift of the upper clouds and as Maury says above, "currents are seen as if the props and stays were taken away from the air, and the winds (aloft) seem to rush violently hither and thither, &c., &c.;" and the first burst of the rains is perhaps ushered in by a W.S.W. squall, followed by a westerly gale.

I always observed this N.W. upper current on the advent of the rains as instanced by the following extract from my diary :—

Sunday, 16th June, 1878, Sandheads.—3 P.M., wind 3—4 S. by W.; overcast and gloomy weather, with a few spittings of rain; it has been threatening all day from the N. and W.; a heavy sea on. And again,—Wednesday, 19th June, 1878, off Kedgeree.—Noon wind 5 S.S.W., and fine weather, scat cu with ci—cu coming from N.W. as it has been for these last three days—a sure sign of the rains. Also Saturday, 22nd June, 1878, in the river Hooghly.—6 P.M., wind 3 S.S.W., a slight shower—a foretaste of the rains.

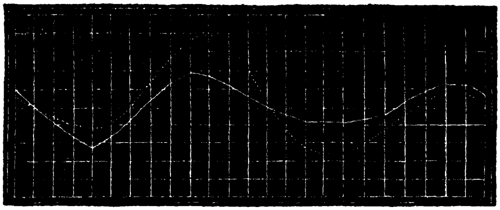
Mr. Blanford in his Indian Meteorologist's Vade Mecum, at page 180, says, when speaking of the branch of the S.W. monsoon which comes from the Arabian Sea and blows right across the peninsula,—"Even in Orissa, the greater part of the rain is brought from that direction;" and I have no doubt, from the almost constant presence of this upper W.N.W. and N.W. current throughout the rains, at the Sandheads at least, that it is the main rain bearing current; for, after the rains have set in, through June, July, and August, and the early part of September, one will often see about three o'clock in the

morning, the tongues of rather low cloud stretching out over the S.S.W. surface wind, from the westward, making one fear (when on the port tack) being caught aback soon: and as the morning advances, these clouds, ever growing denser and more threatening, often get hold of the surface, and with heavy westerly rain squalls, push the original S.S.W. wind aside till, perhaps, 10 A.M., when the weather fines again and the wind gradually takes off and hauls to the southward: this occurs for two or three days running.

Very probably these bursts of rainy mornings are connected with those cyclonical rain storms that now and then, at intervals, take their rise, as Mr. Blanford and also Mr. Eliot tells us, at the N.W. angle of the head of the Bay, in response to the oscillations of temperature and atmospheric pressures always going on in the rains, generally, in periods of about eight or nine days, between Mid-Bay and the land areas: but are, I presume, more intimately connected, as far as the time of day is concerned, with the diurnal oscillation of baric pressure, which Mr. Blanford, at page 190 of his Indian Meteorologist's Vade Mecum, describes graphically; he says:—"The figures show in a very striking manner how, *cæteris paribus*, the pressure preponderates over the land (Calcutta) up to 1 P.M.; after which it preponderates over the sea (between 20° N. and the Sandheads) up to 1 A.M." Mr. Blanford's explanation shows that this daily oscillation between sea and land is "otherwise expressed by the diurnal land and sea breezes."

I here add a facsimile of that gentleman's diagram (see next page) from his *Vade Mecum* showing the difference between the Calcutta and Sandheads baric curves of one day.* The plain curve showing the pressure over the Sandheads, and the dotted curve that over Calcutta.s

* And doubtless this double diurnal oscillation of baric pressure has its influence on the tides of the river, which should not be overlooked; just as the great yearly oscillation north and south—from over the land to the sea area, and *vice versâ*—alters the mean level of the water in the river. See Tides, 375.



But often these cyclonic rainy bursts take their rise further south than the Sandheads; in that case they are preceded by the usual calm and sultry weather, and then N.E. squalls, which, probably, have been foretold for days before by the clouds' motion up aloft: and in case the wind comes from N.E., at any time between June and October inclusive, bad weather may always be expected to follow. The wind generally goes round with the sun, and therefore with a S.E. gale, the N.W. angle of the Bay is an awkward spot to be caught in, as there is sure to be a strong, westerly set: and as the wind gets to the westward of S.S.W. it pipes up hard, and a heavy southerly sea runs at the Sandheads.

So, in running up the Bay great attention should be paid to the barometer during this and the two following dirty months; and do not run north, if the glass is falling too fast for the distance run; in connection with which the table of barometric pressure at the various stations on both sides of the Bay will serve as a guide, see 380.

The late Mr. Willson, in his Report of the Midnapore and Burdwan Cyclone of the 15th-16th October, 1874, says as follows:—

"The storms which visit the shores of Bengal at the commencement of the south-west monsoon are usually generated in the northern part of the Bay, and the atmospheric disturbance which precedes them appears to be sufficiently near to effect considerable pressure and gradients, and the general character of the weather round the north of the Bay for some days before they are formed. The barometer falls steadily and considerably generally four or five days beforehand. The atmospheric gradient between Calcutta and Saugor Island becomes reversed in direction" (in the months of May and

June the atmospheric pressure to the north of the Bay is rapidly decreasing to the solstitial minimum—29·562 for June and 29·543 for July at Saugor Island, as we find in Mr. Blanford's mean annual baric pressure table for these months)—" but during the same period the decrease of pressure to the south of the Bay is very inconsiderable. In June the average gradient between Port Blair and Saugor Island is about two-tenths of an inch of mercury. In October the pressure to the north of the Bay is rapidly rising, the rate of increase being more than twice as great as the rate of fall in the former season, pressure at Saugor Island falling below that at Calcutta" (normally the pressure at the former place is higher by ·017 in May, by ·011 in June, and by ·002 in July, but in August the gradient is reversed), " and north-easterly winds become prevalent at the head of the Bay. At this time of year (May and June) the normal wind directions in this locality are southerly and south-westerly, and winds from the north-east" (the cyclone quarter) " are very unusual. * * * * * Thus the weather indications which precede the actual formation of a cyclone in the northern part of the Bay, at the commencement of the S.W. monsoon, are clearly defined; whereas in the case of a storm coming up from the middle or southern parts of the Bay, only the indications which precede the actual approach of the cyclone are noticeable."

And with reference to the normal baric gradient of the Bay, Mr. Eliot in his paper " On Storms in Bengal during the year 1876," says,—

" Our knowledge of the distribution and variation of atmospheric pressure in the Bay is imperfect. Assuming, however, that the pressure at Port Blair (Andaman Islands) and Saugor Island indicate roughly and generally the relation between the pressure of the Mid-Bay and the coast of Bengal, the preceding tables seem to establish the following general conclusions :—

" 1*st.*—That, during the rains, the baric differences between the Mid-Bay and the Bengal Coast are in a state of continuous oscillation, indicating an action between the Bay and the land, oscillatory, and not constant and continuous in its character.

" 2*nd.*—That an increase of the baric difference, above the normal amount, is accompanied or followed by the advance of a saturated current from the Bay to the coast.

"*3rd.*—That this saturated current is determined, first of all, generally to the north-east, giving the heaviest rainfall to the Arakan Coast, advancing from Akyab northwards, and gradually extending northwards and westwards over Bengal.

"*4th.*—That the effect of this indraught from the Bay and the condensation of its moisture over Bengal is an increase of pressure in Bengal, and (usually) a slight increase in the Mid-Bay. The baric differences consequently diminish, and after a time this change is followed by a partial or entire cessation of the heavy rainfall."

And with reference to these cyclonic bursts of storm and rainfall in the north of the Bay and over the adjacent coasts so prevalent during the rains, another instructive extract from the above-named gentleman's Report of the Madras Cyclone of 1877, page 92, is well worthy of a place here. He says :—

"One of the objections that has been recently advanced against the condensation theory in the case of cyclones of the Bay of Bengal is, that cyclones rarely, if ever, occur in that area during the rainy season. The employment of such an objection is due either to ignorance of the character of the weather in the Bay of Bengal during the south-west monsoon, or to the unauthorized restriction of the term 'cyclone' to one kind of cyclonic disturbances.

"If no other condition was necessary for the generation of cyclones than heavy continuous rainfall, that is, if the theory required (which it does not) that heavy rainfall should be invariably followed by a cyclone, the objection would be valid and fatal, if in addition it could be proved that there is an entire absence of cyclonic disturbances during the height of the south-west monsoon. Intense cyclonic disturbances, such as are usually called cyclones, and the fame of which alone spreads to Europe, undoubtedly occur only at the two transitional periods, the meteorological features of which have been fully analyzed in * * * But the rainy season from June to September, it is well known, is essentially the season of stormy weather in the Bay."

Here follows a quotation on the weather at this season from Captain Taylor's useful Indian Sailing Directory. He then goes on to say :—

* * * "This continuous examination has shown that, dur-

ing the rainy seasons 1877 and 1878, heavy and continuous rainfall in Bengal and Northern India, in the majority of cases, accompanied the advance of cyclonic disturbances, or revolving storms of considerable extent, but of small intensity, from the Bay, which were gradually dissipated over the land area of Northern India. Mr. Blanford's examination of two storms during the rainy season of 1876—the one accompanied with excessive rainfall at Allahabad and its neighbourhood, and the other at Delhi—established that they were revolving storms, which proceeded from the sea coast to the interior, where they were gradually dissipated. This gave the first clue to the character of the storms of the rainy season. It is too early to generalize broadly; but recent experience and, as I believe, theory both indicate that cyclonic disturbances are a very common feature of the rainy season or south-west monsoon."

Mr. Eliot then gives a tabular statement of six of the most "conspicuous of the cylconic disturbances, the paths of which were traced, day by day, from their appearance at or near the coast to their dissipation in the interior, during the months of August and September, 1877;" and as I believe my diary will help to show the shipmaster what sort of a sky to look for both before and during the prevalence of one of those cyclonic storms at the head of the Bay, I will here go along with Mr. Eliot's table:—

No. 1.—'Cyclonic disturbance of August 5th to 10th.' "This was generated off the coast of Arakan, advanced a short distance to the west of Chittagong over Dacca into Northern Bengal." Of this one my diary says little. It says,—Sunday, 12th August, 1877, since I came out (to the Sandheads) last Monday, when it certainly was looking greasy and dark to the S.E., we have been through a westerly gale with lots of rain which cleared off two days ago, and now we have light S.E. winds and fine weather.

No. 2.—'Cyclonic disturbance of August 11th to 13th.' "This was a small one which originated to the south of the Sandheads, passed over Saugor Island, and shortly afterwards disappeared." Of this one my diary says, continuing from the last day given above—Sandheads, 12th August, 1877.—A.M., light S.E. winds and fine weather. See lots of brown scum on the surface of the water and lots of fish

jumping about. P. M., easterly airs. Monday, 13th August (Sandheads), 1877.—6 P. M., wind 3 N.E. cu—s and ci—mares' tails aloft. I think we are in for a breeze; barometer 29·56. 8 P. M., barometer 29·59; wind 3 N.E. by E. cu—ci—s and ci; vivid lightning to N.W. in heavy cu.

Tuesday, 14th August, 1877 (Sandheads).—8 A. M., barometer the same as at 8 P. M. last night. Wind has gone round to N. by E. cu—ci—s with ci—cu. 10 A. M., barometer 29·58; wind 2 N.N.W.; rain squalls, which have worked across from the eastward, where I believe there is a gale: I saw a short time ago a decided bank there, its fringes aloft with ci—cu hinting at the same thing, and, then again, there are the long low-bands or belts of drifting cu, and the tops of the cu to the N.W. torn away as if by a strong N.E. current, and also the dashes of ci stretching across the cu (and low and close) showing that this is a cyclonic disturbance, and again the barometer is about ·15 lower to-day than it was two days ago. The sky looks ugly to the southward and S.E. and full of rain. 2 P. M., barometer 29·51; wind light, N.W. by N. o, dark and gloomy r r. 4 P. M., wind fresh, West; barometer 29·52. 8 P. M., wind 5 W.S.W.; barometer 29·56.

Wednesday, 15th August, 1877 (Sandheads).—10 A. M., wind 5 W.S.W. cu; barometer 29·68. 4 P. M., barometer still high; sea very rough; ships around in want of pilots, and our boat is smashed. 8 P. M., 1 to N.W., midnight o with cu from N.W.; barometer 29·64. See by the tops of the cu that there is still an upper N.E. current.

Thursday, 16th August, 1877.—6 A. M., r r; wind 3 to 4 W.S.W. q; barometer 29·71. Was put on board as pilot of the ship "Eastern Light," Captain Evan Jones. Ran in and anchored at Saugor.

No. 3.—'Cyclonic disturbance of August 17th to 22nd.' "This was formed off the Arakan Coast, and advanced over nearly the same area as No. 1. It was dissipated on the 22nd in Northern Bengal."

Of this disturbance I have no notes in my diary.

No. 4.—'Cyclonic disturbance of August 28th, 29th, and 30th.' "This was formed in the north of the Bay, advanced across Saugor Island and the mouth of the Hooghly on the morning of the 30th, and was broken up during the day."

Concerning this disturbance my diary says as follows:—
Off Kedgeree bound out in pilotage charge of the S. S. "Crusa-

der," August 29th, 1877, 5-30 A.M., a brisk N.E. squall with rain. The barometer was up to 29·82 yesterday, which has been about its height for some days. 9-15, weighed and proceeded; wind 2 N.N.E. o. Noon, at Saugor, wind 2 N., partially o, cu—s; barometer 29·70. 2 P.M., in Gasper Channel; wind 2 N.E.: yesterday, when at Kookrahatty, I smelt a peculiar exhalation from the water, and I now smell it the same. I wonder whether the N.E. squall this morning was the precursor of easterly winds? It seems so, and that is why the barometer has been so high lately. 5 P.M., barometer 29·72. 6 P.M., I was taken out by the pilot brig "Cassandra." Wind 4 N.N.E.; heavy threatening weather. I had to pull through a thick and heavy squall to get to the brig, which turned out to be the commencement of a cyclone. 10 P.M., hard squalls from N.E. r r; barometer 29·66. Midnight, barometer 29·54; heavy squalls from N. to N.E.

Thursday, 30th August, 1877 (Sandheads).—3-30 A.M., heavy northerly squalls; barometer 29·33. 3-45 A.M., the fore top gallant mast and jibboom went. 6 A.M., wind 6 N.W.; barometer 29·40. 8 A.M., wind 6 W.N.W.; barometer 29·45. 10 A.M., wind 4 S.W.; barometer 29·55. Noon, wind 4 S. by W. 4 P.M., wind 4 S.; barometer 29·65. 8 P.M., wind 3 S.; barometer 29·72.

Friday, 31st August.—7 A.M., was put on board in pilotage charge of ship "Jura," Captain R. Russell; wind 3 S. by E.; barometer going up again, and signs of a strong E. or S.E. wind up aloft, the tops of the cu being dragged out like jets of steam from a pipe, or rather a flame from a blowpipe. This ship after running away to the southward last night for only two hours, got into fine weather. The pilot brig hugged the wind on port tack all the time and so lost her fore top gallant mast and jibboom. 4 P.M., anchored off Kedgeree; wind 3 S.E. fine all day. 8 P.M., barometer 29·78.

But I think I have shown ample proofs that the upper current indicated well what sort of weather to expect; and I would refer the reader back to another extract from my diary, dated 26th June, 1879, for another example, which also may assist a stranger when making the Pilot Station in the rainy season, or from June to October; it will be found at page 193, so that there seems every probability that all storms are cyclonic in their nature, small or large.

Against the westerly tendency of the winds at the head of the Bay, Captain Heckford, in his useful Sailing Directions, warns his readers, and he says :—

"This is one of the months of the year, from the middle to the latter part, when the monsoon blows hard with heavy squalls;" and he also says at another place, with reference to vessels coming to the Sandheads from Rangoon and Moulmein :—"Every advantage should then be taken to get to the W.S. westward, and in proceeding to the northward from the north channel, a N.W. by W. course should be preserved for one or two days to check the probability of a westerly wind prevailing at the head of the Bay."

For Barometer, Wind Force, and Wind Direction, see tables 375—380, &c.

In Syvret's "Sailing Directions for the Sandheads," we read :—

"In the month of June the strong S.W. wind commences to lull, and the weather is more unsettled than the last three months; towards the middle of the month, the 'Chota Bursat,' or small rain, commences, which usually lasts for a fortnight, after which the weather clears up again; the wind generally inclines more to the westward, and sometimes we have a westerly gale; the north-westers begin also to lose their strength, and generally end more in rain than wind. Thunder-storms are usually heavy this month, but on the whole, the weather is generally passable, but intolerably hot."

373. **July.**—As Captain Heckford in his Sailing Directions says :—"This is without exception the worst and most severe month of the year." A time to well try canvass and running gear. "The monsoon blowing hard with frequent and heavy squalls." In this month, as in the latter part of June, the same rule applies, which I set forth elsewhere, that, as soon as the wind veers to the westward of S.S.W., dirty weather may be looked for.

Mr. T. Syvret, late licensed Hooghly pilot, said in his useful little book :—"S.W. to S.E. wind generally prevails, but when the weather is unsettled, W. and W.S.W. winds prevail." Also he says, truly :—"Before a gale occurs, the

sea generally rises very quick; a heavy swell comes rolling in from the southward: after the gale is over, it goes down nearly as fast; but there is generally more swell at this season than at any other time." Mr. Syvret also notices that,—"A N.E. or E.N.E. wind, accompanied with rain and squalls, is sometimes the forerunner of a westerly gale."

These westerly gales at this, the N.W. corner of the Bay, do cause a set to the eastward while they last, and until the wind gets to the southward again; but the easterly set is not to be compared in strength to the westerly set, which gets up with the commencement of even one of the rain whirls or storms of the S.W. monsoon, and whilst the winds are from N.E. to S.E.

Mr. Blanford tells us in his "Winds of Northern India" concerning the baric gradients between the south and north, that "in July no further change of importance occurs; the pressure has reached its annual minimum" (that is, over the land); see the barometric table, 380, and which table should be consulted with the sky appearances when running up the Bay during the whole of this season for fear of running into one of those rain whirls that may happen to be just brewing up in the northern part of the Bay, ready to start on its journey over the land, as before noticed: and it should be remembered, that, with a westerly wind, a ship can not get into Saugor; so that in case the winds are blowing hard from West, or W.S.W. even, with the usual dirty weather and heavy sea, it is perhaps best to jog along easy and let the blow pass off, and wait till the wind hauls round to the southward again, with moderating weather, before pressing for the Pilot Station.

I have often seen the pilot brigs, during July and August, reduced down to bare poles for two or three mornings running, in these recurring dirty bursts of rain and westerly wind, which brew up (as I have noticed before) between daybreak and 10 or 11 A.M.; such was the force of the wind: and as the sea gets up in proportion to the wind,

and as the weather is so thick, there is nothing left for it but to reduce sail and stand down on the starboard tack, not forgetting, however, that the weather generally brightens up by noon, unless it is connected with some far-spreading cyclonic storm, which has begun with the usual N.E. winds that have gone round either north or south about, to west.

So under such circumstances of dirty weather and heavy sea, shipmasters may experience, in this month and also in the next, some delay in getting their pilots, the brigs, of sheer necessity, being off the Station.

By the latter part of the month the mean wind direction has begun to get more to the southward, after its westerly tendency at the first burst of the rains in June. And between the 'oscillations' of baric pressure, or spells of bad weather, the wind is generally between S. and S.S.W. after 1 P. M., when, Mr. Blanford in his Meteorologist's Vade Mecum tells us, the barometric pressure preponderates out over the sea within 100 miles of the coast line of Bengal until 1 A.M., and, as before noticed, in the rains, at the Sandheads, this diurnal oscillation of baric pressure, and consequent alteration in the wind direction and force, is very well marked; and ships that could not lay N.W. ½ N. through the Gasper Channel in the morning, are very likely able to do so on the P. M. tide: of course, excepting in those heavy westerly gales which sometimes last for three or four days, or more.

Captain Maury in his fourteenth edition of Physical Geography of the Sea surmised something of this diurnal oscillation of baric pressure, which Mr. Blanford has proved to exist between the Sandheads and the interior, over the land.

He says at page 373 :—" Land and sea breezes are monsoons in minature, for they depend in a measure upon the same cause. In the monsoons, the latent heat of vapour which is set free over the land is a powerful agent. In the land and sea breezes, the heat of the sun by day and the ra-

diation of caloric by night are alone concerned. In the monsoons the heat of summer and cold of winter are also concerned. But could the experiment be made with two barometers properly placed—one at sea and the other on land, but both within the reach of land and sea breezes—they would show, I doubt not, regular alterations of pressure. In the sea breeze, the land barometer would be low and the sea high, and *vice versâ* in the land breeze; and when the barometer was highest and when it was lowest it would be calm at the barometric stations."

During this month the freshets in the rivers make down, which, probably, augments the westerly set between the hard westerly blows, and which runs sometimes 3 or 4 knots in easterly winds during July, August, September, and also, as I have said, in October.

We read at page 94 of Mr. J. Eliot's Report of the Madras Cyclone of 1877:—"Mr. Blanford's list of Cyclones indicates that no intense cyclone, such as those which characterise the two transition periods, has ever occurred during the rainy season (from July to September)."

For further information concerning the weather, I refer the reader to what has been said about June.

See also Baric, Wind, and other tables, 375—380.

374. **August.**—Up to the middle of this month the weather at the Sandheads is, on the whole, similar to July: but as the month advances and the barometer over the land begins to rise a little, the monsoon winds begin to weaken and back into the S.E. more frequently; which, with the strong westerly set running, makes this, the N.W. corner of the Bay, an awkward cruising ground, more especially during one of the whirls which are prevalent during the rains, should they pass to the southward of the Sandheads on their westerly course: vessels sometimes being driven over into Balasore Roads, or uncomfortably close to the Reefs of Palmyras Point. It is at such times that a kedge shackled on to the bower chains becomes useful, after the sea has gone down and the winds grow light.

As in July, between the bursts of rain and wind the atmosphere is very clear, and the lights can be seen a long way off. The sheen of the blue lights is sometimes observed at a distance of 32 miles.

It is necessary that vessels have good canvass bent for the navigation of the Sandheads in August. See also Baric, Wind, and other tables, 375—380.

375. **September.**—Although the weather is not so bad in this month as in the two last, still it is not to be trusted; and here I will give an extract from my diary, which will, I think, give a fair estimate of September weather at the Sandheads:—

Sandheads, Sunday, 11th September, 1870.—For the last four days we have had the same old boisterous weather, *viz.*, rain squalls from the southward and lightning at night to the N.W., W., and S.W.: and last night it was heavy and threatening to northward and N.W., with vivid lightning like a north-wester brewing, which struck us and has caused quite a change in wind and weather. All day light N.W. airs and calms. Cu—s to the S.E. and ci.

Monday, 12th September, 1870.—A.M., calm with cu—s and a few straggling pieces of fractu-cu. P. M., cu to N.W.

Tuesday, 13th September, 1870.—Noon, all the day, wind light N.E. to N.N.E. Cu—ci—s and nim. to S.E., where it looks like a gathering of dirt. I fancy this is the commencement of a small cyclonic disturbance, for the barometer has gone up gradually, all over the bay, and the sky has an easterly look about it. v, no swell; bar. 29·90. 5 P. M., we have a beautiful sunset,—the clouds being tinted with green (dark), purple, and all the intermediate colours; and above the cu the 'mares' tails' cross in all directions, showing, on the whole, a change. There is also a low swell from S.E.

Wednesday, 14th September, 1870.—4 A. M., vivid, but distant, lightning (l r) to S.E. 8 A. M., there is a bank of ci—cu—s to S.E., with lots of detached cu, driving with a moderate E.N.E. wind and a cloud of nim. that is dropping rain to the westward has been attempting to send down a waterspout on its N.E. or weather side, the tube reaching but a short distance down from the straight and level

under edge of the cloud (the vapour plane). The bank to the S.E. is as blue as the sky above its verge, excepting its white upper edges. There is also a little ci showing out above it: and, with the high barometer, clear atmosphere, sultry weather, and bright sun (Venus looked very large and bright this morning), I feel certain that the increasing swell from the S.E. is caused by a cyclonic breeze, which, I think, is working up the bay. There is a strong set to the westward likewise. The bank of cloud to the S.E. is about 25° high; barometer at 8 A.M., 29·90. 4 P.M., arched and strong E.N.E. squalls with rain, and the weather looks dirty all round. There is a little more S.E. swell; barometer 29·94. The tops of the squall-clouds go pretty high and fan-shaped form ci, ci—s. This is the first squall we have had, and it has freshened the wind up considerably as well as raised the sea; so that I fancy we shall be underweigh to-night. We have been at anchor ever since the southerly winds were done on the 11th. At 8 P.M., saw distant lightning to E.N.E., and in a squall with rain which we have just had the wind has shifted to E.S.E. fresh.

Thursday, 15th September, 1870.—10 A.M., wind moderate S.E. to S.E. by S., cu and ci—s. The appearances I saw lately have not yet developed into a gale as I had expected.

Friday, 16th September, 1870.—Noon, barometer 29·85; wind very light easterly cu—s. There is still a long swell from S.E.

Saturday, 17th September, 1870.—All night calm and light S.E. airs. Noon, a very light film of ci—s has gradually worked up from S.E. since daybreak, and is now a little beyond the zenith. Cu in the S.E., and clear to N.W., with scat cu here and there, their tops evidently turned by a southerly current. Wind light east with considerable swell from about S.S.E. Saw a stormy petrel yesterday; and last night saw lightning to the N.N.E. Had a beautiful sunset (golden). The distant cu standing out against the golden sky like tall rocks tinged with red and bright gold at their edges; and, after dark, a tall, isolated cloud, growing up like a spreading piece of coral on the northern quadrant to above 30° of altitude was quite alive with vivid lightning flashes. Wind light E.S.E.

Sunday, 18th September, 1870.—10 A.M., wind 2—3 N.N.E., hauling to E.N.E. now and then. The clouds, cu, are coming from S.E., where they are pretty dense. There is still a considerable and regular swell from about S.S.E.,

the crests of the swell-waves can be traced in almost a straight line for a quarter of a mile in length. The north-western sky is clearer, but near the horizon there is cu—s. Cu—s above the driving, low cu. There is still a westerly set. P.M., cu—s and ci. 7 to 8 P.M., much 1 to S.E. and S. This means mischief I believe.

Monday, 19th September, 1870.—10 A.M., wind 2—3 East, cu—s all round. Barometer still above 29·90, and there is less swell to-day. We had two or three heavy showers between 3 and 4 this morning. I see no signs of phosphorus in the sea at nights. v. P.M., showery passing squalls, a strong westerly set, and a swell from S.E., and also S.S.E. Cu—s, pile cloud and ci.

Tuesday, 20th September, 1870.—3 A.M., wind fresh E.S.E., with heavy clouds and driving cu, 1 to N.E.; barometer 29·80. Noon, moderate E.S.E. winds with rain squalls, cu, s, and ci. We have drifted to near the South Channel buoy, there being a strong set, so that I fancy we shall have to weigh and stand to sea to get to the eastward. 2 P.M., weighed and stood out; wind fresh E.S.E., and at 8 P.M., tacked and anchored near the Eastern Channel Light at midnight.

Wednesday, 21st September, 1870.—6 A.M., the easterly winds seem to have broken up. 8 A.M., wind variable between N.E., with thunder and rain squalls. There is still a considerable westerly set. Noon, wind S.S.E., cu and ci. 9 P.M., I was put on board in pilotage charge of "Houri," Captain W. H. Stapleton.

Thursday, 22nd September, 1870.—Last night just after midnight we anchored near the Spit Buoy, and at 9 A.M., as the wind sprung up from the westward, we weighed and stood out. But afterwards the wind hauling to the S.S.W., we stood to the northward again; but about 10 A.M., on getting to the Middle Ground Buoy, I had to anchor, as the wind hauled to the westward and fell light. The weather looks very ugly and greasy to the southward. 4 P.M., the wind again hauling to S.S.W., weighed on the flood; but soon the wind veering into the westward, anchored again near the Middle Ground Buoy and C. S. S. Buoy. Sunset, wind freshening and weather closing in squally and looking wild and dirty, especially to the southward, with a nasty swell rolling up channel, increasing fast, so that I wish we were safely out to sea. There is a ship anchored near the Gasper Light, inward bound.

Friday, 23rd September, 1870.—A.M., have passed a very dirty and wild night, the wind continually howling in fearful rain squalls from N.W. to S.W., attended with very vivid lightning, thunder, and heavy rain; and as a very heavy sea got up when the flood made, at daybreak, I let go the second anchor. At high water weighed and ran into Saugor and anchored in the Dredge Channel at 6 P.M.; wind strong and squally S. to S.W., nim. and ci.

Saturday, 24th September, 1870.—There was such a strong wind with the flood that we could not purchase the anchor, nor indeed heave in a link of chain until the tide turned.

I have since learnt that the ship which was anchored in company with us on the night of the 23rd September was nearly lost, she having parted on the ebb tide on the night of the 24th, and having to run through the Gasper at low water. So that, although better than the two last, September may be called a rather treacherous month for the navigation of the Sandheads. Before the anchor could be secured on board the "Houri," several sheets of copper were torn off by the anchor, so high was the sea.

As the weather is so liable to change, and as there is always such a strong westerly set at the Sandheads, vessels inward-bound should endeavour to watch, and in the event of easterly winds, expect the westerly set to be stronger, and so make allowance for it when striking soundings off the tails of the sandbanks, or they may be set away for many days. Syvret's little book tells us truly of this month, that it "may be noted for its light variable winds and calms, showers of rain, with occasional puffs of wind from the south and eastward (it being about the breaking up of the rains). Easterly winds will be found to be the prevailing winds this month; and a set to the westward will be experienced at the Sandheads, more or less in strength, according to the strength and length of time the easterly wind has been prevailing. Vessels should, therefore, keep to the eastward, &c., &c."

THE MARCH OF THE MONSOONS DOWN THE BAY OF BENGAL—MAURY'S TABLE.

376. **Maury's Wind Table.**—Table showing the march of the monsoons down the Bay from Captain Maury's Physical Geography of the Sea, and which gives in days the average monthly duration of the N.E. and S.W. winds at sea between the parallels of—

	22° & 20° N.		20° & 15° N.		15° & 10° N.		10° & 5° N.		5° & 0° N.	
	Days. N.E.	Days. S.W.	Days. N.E.	Days. S.W.	Days. N.E.	Days. S.W.	Days. N.E.	Days. S.W.	Days. N.E.	Days. S.W.
January...	17	6	21	2	23	1	20	1	19	3
February	11	11	13	6	19	3	22	1	16	2
March ...	4	18*	7	15	8	5	13	0	15	2
April ...	2	24	2	22	6	12	6	11	4	14
May ...	1	26	1	24	3	21*	1	23*	0	19*
June ...	0	28	1	27	0	29	1	25	0	24
July ...	2	24	1	27	0	30	0	28	0	24
August ...	0	28	1	24	0	24	1	22	0	18
September	6	14	1	18	0	23	0	26	1	18
October...	9	6	12	6†	8	10	6	16	4	14
November	11	6	25	2	21	2†	10	6	5	14
December	27	0	26	1	24	1	15	3†	12	11

We thus see, from the above table, that between Calcutta and the line the S.W. monsoons are the prevailing winds for seven months; the N.E. for five.

And to assist the mariner still further, I quote once more from Mr. Blanford's Indian Meteorologist's Vade Mecum, page 181,—The relative prevalence of the winds in the Bay and down to the equator is admirably shown in the following table, which is extracted from that given by the late Lieutenant Cornelissen in his valuable work "Route voor Stoomschepen van Aden, etc." The first table gives the winds between east longitude 80° and 90° on the western half of the Bay; and the second those between 91° and 100° or in the eastern half, in successive strips of 5° latitude down to the equator.

* Setting in of the S.W. monsoon. † Ending of the S.W. monsoon.

377. Cornelissen's Wind Table. — Winds between 80° and 90° East Longitude:—

N. Latitude.	Winds.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
15° to 20°	N. to E.	93	43	23	6	5	2	1	3	7	37	74	68
	E. to S.	9	11	19	18	20	9	5	10	16	20	6	1
	S. to W.	10	27	33	66	68	83	84	75	58	22	8	8
	W. to N.	14	15	16	7	6	4	10	11	17	16	10	22
	Calms ...	4	4	9	3	1	2	...	1	2	5	2	1
10° to 15°	N. to E.	79	67	50	17	7	1	...	1	4	26	52	72
	E. to S.	11	18	22	35	20	8	5	11	9	25	23	16
	S. to W.	3	7	10	31	59	80	85	64	73	29	8	4
	W. to N.	5	6	10	9	9	7	6	23	13	12	16	6
	Calms ...	2	2	8	8	5	4	4	1	1	8	1	2
5° to 10°	N. to E	72	76	58	25	4	1	1	1	1	16	31	27
	E. to S.	12	11	19	29	14	7	4	13	3	15	20	20
	S. to W.	7	5	7	31	64	78	76	74	81	49	22	10
	W. to N.	7	6	12	11	16	11	18	11	14	18	21	20
	Calms ...	2	2	4	4	2	3	1	1	1	2	6	3
0° to 5°	N. to E.	54	53	40	16	3	...	...	...	4	8	16	46
	E. to S.	12	14	17	21	16	25	16	19	17	8	10	8
	S. to W.	11	7	10	33	49	59	65	56	58	48	35	26
	W. to N.	21	22	23	24	25	15	17	22	20	35	35	19
	Calms ...	2	4	10	6	7	1	2	3	1	1	4	1

Winds between 90° and 100° East Longitude:—

N. Latitude.	Winds.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
15° to 20°	N. to E.	55	42	12	5	1	...	...	2	13	37	66	69
	E. to S.	3	4	7	7	10	12	2	1	8	18	15	2
	S. to W.	8	12	14	44	65	80	91	90	61	12	4	4
	W. to N.	29	36	60	33	17	5	6	6	13	28	14	24
	Calms ...	5	6	7	11	7	3	1	1	5	5	1	1
10° to 15°	N. to E.	78	53	42	29	7	...	2	...	...	22	53	83
	E. to S.	6	3	8	13	6	9	5	6	4	20	18	8
	S. to W.	...	4	8	24	63	82	87	79	77	25	10	1
	W. to N.	12	36	33	27	16	8	5	14	15	27	17	7
	Calms ...	4	4	9	7	8	1	1	1	4	6	2	1
5° to 10°	N. to E.	66	65	64	24	4	1	5	6	2	21	48	72
	E. to S.	12	8	11	22	12	17	18	14	11	16	22	12
	S. to W.	4	3	7	22	67	71	68	63	56	33	9	2
	W. to N.	15	20	12	24	11	10	8	11	27	26	16	13
	Calms ...	3	4	6	8	6	1	1	6	4	4	5	1
0° to 5°	N. to E.	34	28	27	11	5	4	8	5	3	11	15	22
	E. to S.	11	9	18	16	18	23	18	14	16	21	15	13
	S. to W.	17	19	17	42	51	58	46	54	62	29	27	16
	W. to N.	31	31	23	23	20	10	20	16	13	31	38	36
	Calms ...	7	13	15	8	6	5	8	11	6	8	5	13

TIDAL CURRENTS AND SEA-SET.

378. **The Tides.**—The mean height of the waters in the estuary and river is like that of all other littoral waters, affected by the fluctuation or oscillations of relative barometric pressure between sea and land areas; but it is in this river the more so, since the oscillations invariably take place in a line with the river north and south, or between the land and the sea due south of the river; and, first, there is the yearly oscillation and sudden reversal of the baric gradient in September and October, as we read in Mr. Blanford's valuable work, the Indian Meteorologist's Vade Mecum, at page 177:—"The relative distribution of pressure undergoes but little change during the rains, except that it rises gradually after June or July, and most so in the Punjab; until, about the end of September or beginning of October, a rapid rise in this region transforms it from the seat of the lowest to that of the highest pressure. This rise is general over Northern India, but the southern part of the Bay remains unaffected, and in most years, the Bay becomes an area of low average pressure, completely circumscribed by slightly higher pressures, &c., &c." And which certainly does alter the mean height of the half-tide level as we find on a reference to the table given below; for we see that the half-tide level for September is 11 feet 6 inches, whilst that for November is 9 feet 4 inches, a difference of 2 feet 2 inches, which the cessation of the southerly and the incursion of the northerly winds cannot altogether account for.

Half-tide level of the Hooghly at Moyapore, taken from

an average rise and fall table by J. Obbard, Esq., River Surveyor, of the day tides of each month of the year :—

		Ft.	In.			Ft.	In.
January	...	7	6	July	...	10	6
February	...	7	6	August	...	11	5½
March	...	7	9½	September	...	11	6
April	...	8	10	October	...	11	. ½
May	...	9	7¼	November	...	9	4
June	...	9	10	December	...	8	3

The semi-diurnal tides are also affected by that oscillation of the baric pressure which goes on continually day by day between the land and sea areas, better explained in Mr. Blanford's own words.* At page 190 of the above quoted work we read :—"The figures show in a very striking manner how, *cæteris paribus,* the pressure preponderates over the land (Calcutta) up to 1 P.M., after which it preponderates over the sea (between 20° North Lat. and the Sandheads) up to 1 A.M.," and this excess of relative baric pressure over the sea must independently of the wind which as a sea breeze probably springs up to maintain or recover the lost equilibrium which the heating power of the sun's rays has caused; and therefore, in the last of the neaps, or at that period of the lunation when the flood tide makes about 1 P.M., the flood will be accelerated and exalted by this force, and its returning ebb will be retarded by it. And in like manner the A.M. tide will be kept back in strength and velocity by the opposite effect of this potent force, thus producing a greater or less inequality of the semi-diurnal tides to be debited to differences of baric pressures only.

And, so, during the year, any abnormal change of state in the relative barometric pressure over the sea and land (independently of the wind), plays its part in those extraordinary differences between the calculated tide tables of our River Surveyor and what actually takes place, which we now and then are astonished with, thus :—On the

* See Diagram, p. 225 of this book.

10th March, 1881, the tide only rose to 9 feet at Atcheepore, whilst the tide table gave for that day a rise of 11 feet; and on looking over those useful weather charts issued by Mr. Eliot the Meteorological Reporter to the Government of Bengal, we find it was due to just such an abnormal state of relative pressure on the days about the 10th March; certainly there was little or no southerly wind as usually blows strong at this time of the year.

So, with the rush of the stormwave up the river on the advent of a cyclone:—Is it not the difference between the atmospheric pressure over the land and sea areas,—the great difference of, perhaps, 2 inches of mercury between the advancing storm centre, now over the land, and the fast rising barometer of the sea area, where the storm has blown itself out,—which causes the water to rush (drawn or pushed) up the river, amid the revolvings of the hurricane winds?

Another condition which affects the height of, and makes an inequality in, the semi-diurnal tides, is the fact which I have noticed often, that, when the moon has extreme south declination, the tide which comes on whilst she is above the horizon is the highest of the two, and *vice versâ*. This inequality is intensified if, too, the sun's declination tallies with the moon's,—that is, both north or both south.

But, of course, the great friction of the winds blowing over the surface and raising the level of the lee waters of the estuary must not be ignored, whilst considering the influence due to the oscillating aerial pressure above noticed; for it is well known to pilots that the winds exert great force over the waters of the river and estuary both in checking or holding back, and in accelerating the tides: and I merely mention the above effects to set others on the right path to try and clear up some of the discrepancies which are to be observed in our tide tables when they are compared with actual tides, and which are due to causes not calculable by the compiler of them, at least these abnormal variations in the baric pressure which now and then occur.

379. The Tidal and Sea-Set at the Sand-heads.

That the direction and rate of the tidal current may be approximately estimated for any period of a tide at either of the outer Light Stations, I here insert a copy of the resultant of each of their registers for the same spring-tide day, the 8th August, 1880. The day chosen is one in which there happens to be but little set either east or west. But this state of the set is rather abnormal, as a perusal of the large table (page 249) will show most conclusively.

The rate is given in knots per hour :—

Hour.	Pilot's Ridge Light Vessel.	Eastern Channel Light Vessel.	Mutlah Light Vessel.
1 A.M.	South 1 knot	South 2 knots	S. S. E. 1 knot.
2 ,,	S. S. W. 1 ,,	,, 2½ ,,	S. S. E. 1 ,,
3 ,,	S. W. by S. 1 ,,	S. S. W. 3 ,,	S by E. 1 ,,
4 ,,	S. W. 1 ,,	,, 2½ ,,	South 1 ,,
5 ,,	S.W. by W. 1 ,,	West 1½ ,,	S. W. ¼ ,,
6 ,,	West ¼ ,,	N. W. 1½ ,,	Slack water.
7 ,,	W. N. W. ½ ,,	,, 1½ ,,	......
8 ,,	N. N. W. ¾ ,,	N. N. W. 1½ ,,	......
9 ,,	N. W. by N. ¾ ,,	,, 1½ ,,	......
10 ,,	N. W. ½ ,,	North 1 ,,	......
11 ,,	E. S. E. ½ ,,	East ¼ ,,	......
12 ,,	S. by E. ½ ,,	S. E ¼ ,,	S. E. ¼ knot.
1 P.M.	S. S. W. ¾ ,,	S. S E. 1½ ,,	,, ¼ ,,
2 ,,	S. W. 1 ,,	S. by E. 1¼ ,,	S. S E. ¼ ,,
3 ,,	S. S. W. 1¼ ,,	South 1¼ ,,	South ¼ ,,
4 ,,	South 1¼ ,,	West 1¼ ,,	S. S. W. ¼ ,,
5 ,,	S. W. ¾ ,,	N. W. ¾ ,,	W. S. W. ½ ,,
6 ,,	West ¼ ,,	N. N. W. 1 ,,	W. N. W. ¾ ,,
7 ,,	Slack water	North 1½ ,,	N. W. 1 ,,
8 ,,	......	N. N. E. 1¼ ,,	N. by W. 1 ,,
9 ,,	......	N. E. 1 ,,	North ¾ ,,
10 ,,	......	East 1 ,,	,, ¾ ,,
11 ,,	......	E. S. E. 1 ,,	N. N. E. ½ ,,
12 ,,	......	S. E. 1½ ,,	South ½ ,,
	For the whole day S. W., 6¾ miles.	For the whole day, E. by S., 1¾ miles	For the whole day, S. S. W., 3½ miles.

By the above we see the rate of tide is nowhere above three knots per hour ; but, especially at the Mutlah River Station, the current runs the double of that rate when circumstances are such that a westerly set is started and fairly under-

weigh, as on the advent of an October cyclone: at which time there is but little northing or southing in the current at either the Eastern Channel or Mutlah River Station. Yet, with very strong south-westerly winds and a high sea, I find, by the registers, the tidal current to leeward has sometimes attained to a rate of 3¼ knots at the Eastern Channel Light Station for an hour or so; but such a rate seems of rare occurrence.

A perusal of the set resultants as given in the register of each of the Light Vessels for the year 1880 given at p. 249, shows that there is not so much outset of the current at the Sandheads as one may be induced to expect, seeing the immense quantities of water poured forth from the river during the freshets, but then it must be taken into account that much water is evaporated on the broad expanse of the shoal fresher littoral waters: which, rendered opaque by the clay held in suspension, doubtless receive by day and radiate by night more heat, imparted by the sun's rays, than do the surface waters of the adjacent transparent sea to the south; and, therefore, more vapour must be given off from the littoral waters compared with what is given off by the cooler salt sea to the south, and consequently no water (or very little) runs south, in search of lost equilibrium, caused by the outflow from the rivers raising the water level: but I think the registers show there is rather an inset towards the littoral. And here I may remark that, I believe, when using the hydrometer at the Sandheads the other day, I detected a difference between the density of the dark blue sea water 10 or 11 miles south of the Eastern Channel Light and the green or discoloured water on the 10-fathom line of soundings; the former containing ½ grain less salt per oz. than the latter; but this fact I will prove when I have another opportunity.* Should this be true, it proves most decidedly that there is

* I have since found, that there is in May 1½ grains more salt per ounce in the water at the Eastern Channel Light Station at low water than at high water; or 11 grains at low, and 9½ grains, per ounce, at high water; but see also note at page 248.

more evaporation from off these inshore shallow and muddy waters than there is from off the transparent sea.

This monthly record of the six spring tide days' works, also show well the general tendency of the waters in their flow past the three outer light vessels to have almost a constant westerly set, at least at the Mutlah and Eastern Channel Light Stations, which I have noticed at (359.) Thus giving permanent shape to the Hooghly Sub-Marine Sand-dunes, as I had supposed before I had access to these tide-registers.

The large table (page 249) shows us that, taking the given six days as a fair average for each month, the daily set of the sea over the tails of the sands is as follows :—

For	Pilot's Ridge Light.	Eastern Channel Light.	Mutlah Light.
January ...	......	S.W. 13 mls.	......
February ...	......	S. by W ½ W 5·6 „	W. ½ S. 11 mls.
March ...	E. by N. ½ 6 mls.	S.W by S ¼ S. 2 „	S. W. ¼ W. 3 „
April ...	N. E. ¼ N. 3 „	E. by S. 5 „	N.E. by E ½ E 2 „
May ...	N.W. by W. ¾ W 2 „	S.E. by E ½ E. 2 „	W. by N. 8 „
June ...	N. W. ¼ W. 2 „	N. W. by N. 4 „	W. ½ N. 9 „
July ...	N. by W. ½ W. 3 „	W. ½ N. 4 „	W. N. W. 11 „
August ...	S. W. ½ W. 5 „	W. ¾ N. 11 „	West 23 „
September...	North 4 „	W. ⅛ S. 11 „	W. by S. ¼ S 28 „
October ...	......	S.E. by S ¾ S 3 „	S. W. by W. 5 „
November...	......	S.W by W ¾ W 19 „	W. ½ S. 21 „
December ...	......	S. W. by W. 15 „	W. S. W. 22 „

And that the mean daily set for the whole year is :—

At Pilot's Ridge Station.	Eastern Channel Light Station.	Mutlah Light Station.
N. W. ¼ W. ⅔ mile.	S.W. by W. ¾ W. 6·4 mls.	W. ¼ S. 12·1 miles.

In consulting these Tidal and Set tables, it must not be lost sight of that they are compiled from spring tides only, when the northing and southing element is at its maximum, and that the westing or easting of the current, at least, at both the Eastern Channel and Mutlah River Light Stations, is not dependent on the influence of the moon's attraction, but, as before alluded to, is dependent upon the ever changing conditions of the meteorology of both the sea and the atmosphere resting upon it; and I think it is very significant that the only time there is any easterly set appears, by the records of the year in question, to be March, April, and May, when, as we learn from Mr. Blanford, Mr. Eliot, and Captain Maury, there is high pressure over the centre of the Bay and the winds are anti-cyclonical round it: but that at all other parts of the year, even in July and August when we have had S. W. gales, the set is to the westward over all the Sandheads.

We also see what effect the proximity of the Swatch of No Ground has in giving more velocity to the currents running past the Mutlah Light Vessel than it does to that which runs past the Eastern Channel Light, only thirty miles farther west. What becomes of the excess? May it not be the cause of the strong tide rips sometimes experienced at the Sandheads, as the waters of, perhaps, different temperature and density—those of the littoral and those of the sea, commingle off the mouth of the Hooghly in their chase after lost equilibrium? I simply ask, and doubtless time will solve the question.*

* In August, I have found there are but 6 grains of salt to the ounce of sea-water: and in September, but 5 grains per ounce, at the Eastern Channel Light Station.

BAROMETER, CLOUDS, WEATHER SYMBOLS.

381. **The Reduction of Barometric Observations.**—For the benefit of the mariner, when he wishes to consult the above tables, I here insert a rule from Mr. Blanford's Vade Mecum, whereby he may arrive at a more correct conclusion when comparing his observations with the above tables :—

" *Method of six hourly Observations.*—A method which, in principle, is similar to that of hourly observations, and, though inferior to it, gives results not very far from a true mean in the case of such elements as temperature, pressure, &c., is, to record observations four times daily, at equal intervals of six hours, and to take their average. The best hours for the purpose are 4 and 10 A.M. and P.M. Whenever this plan can be followed, *the proper hours being punctually adhered to*, it is the best substitute for continuous (autographic) or hour registration ; but, if this be not the case,—and it requires the stimulus of a deeper interest or a stronger sense of duty than is often to be met with to carry on such a system punctually and regularly,—it is better to content ourselves with methods less accurate in principle, but the conditions of which are more strictly fulfilled in practice."

382. **On the diurnal oscillation of pressure** (barometric tides), Mr. Blanford says :—

" It needs but to observe the rise and fall of the barometer for a day or two in India to learn the fundamental fact, that the atmospheric pressure undergoes daily a double oscillation ; which is so regular in its occurrence that, except during the passage of a cyclone, it is very rarely indeed masked by the irregular or non-periodic variations. As we recede from the tropics towards the poles, the magnitude of this oscillation diminishes, while those variations of pressure which accompany changes of weather become more marked and of greater amplitude ; so that, in European latitudes, the diurnal oscillation is quite a subordinate phenomenon, and indeed only to be detected by a close study of baro-

metric registers. The general character of the oscillation, as exhibited on the plains of India, is as follows:—From between 3 and 4 in the morning, the pressure begins to rise, slowly at first, afterwards more rapidly; and it attains its maximum generally between 9 and 10 A.M., the exact hour varying at different seasons of the year. It then falls with great rapidity during 6 or 7 hours, and attains the lowest pressure of the 24 hours about 4 or 5 P.M.; the total fall in this interval being, on an average, rather more than 0·1 inch. Again, the pressure rises till about 10 at night, but this second maximum is somewhat less than in the morning. Finally, it falls again, but less rapidly than in the afternoon, and reaches a minimum between 3 and 4 A. M.

"The character of the oscillation, as observed on the plains of India, varies with the season of the year. The longer the day and the drier the atmosphere, the earlier is the forenoon maximum, and the later the afternoon minimum, the greater the amplitude of the afternoon fall, and the greater also the inequality of the day and night oscillations. In the rains, although the days may be as long as in the hot weather, or even longer, the morning maximum falls later, and the afternoon minimum earlier; the amplitude is reduced to its annual minimum, and the day and night oscillations are less unequal. Such appears also to be the character of the oscillations in mid-ocean.

"On low plateaux, such as that of Hazaribagh, the character of the oscillation is similar to that on the lower plains, the amplitude being, however, less; but on mountain peaks and ridges, as at Simla, Darjeeling, &c., the early morning minimum is the absolute minimum of the day; and the amplitude of the forenoon rise of pressure is comparable with the afternoon fall on the plains, while the latter is of subordinate importance on the mountains. Very similar to this mountain curve, in respect of the relations of the two minima, is that of the sea, within a hundred miles or so of the land. Mr. Buchan pointed out the remarkable reduction which the afternoon fall seemed to undergo in the neighbourhood of coasts; but he was probably not aware of the relatively greater amplitude of the forenoon rise of pressure." (See diagram at page 225 of this book.)

"It appears from such registers of marine observations as we possess, that the whole variation is less intense at sea than on land, and this to an extent which can hardly be

accounted for by the greater friction of the mercury in the narrow tubes of marine barometers."

For a clear explanation of the cause of this oscillation of barometric pressure I would refer the reader to pages 187, 188, and 189 of Mr. Blanford's Indian Meteorologist's Vade Mecum.

383. **Kinds of Clouds.**—To enable the mariner to distinguish between the different "kinds of clouds," I here copy from the above work, whose author says:—

"It has been usual in meteorological treatises and registers to adopt Luke Howard's classification of clouds, as was done in the original edition of this little manual. But as Poëy, Fritsch, and Dr. Mann have pointed out, much confusion has arisen in the application of Howard's terminology, partly owing to defects in the original definitions, partly to the misconceptions of those who have adopted this system. In no case is this confusion more apparent than in the application of the term stratus. Howard's stratus cloud is simply fog, whether resting on the ground or at some very small height above it. But misled by the pictoral representations given in illustration of the type, it is a common practice of observers to enter as stratus all clouds which appear as horizontal streaks near the horizon, and which being really high in the atmosphere are generally cirro-stratus. 'Stratus' is an unusual cloud in India, except in the cold weather, in the damper parts of Bengal, and in the evening after sunset. Many of the objections to Howard's classification have been removed by Poëy, who, retaining certain of Howard's classes of clouds, has reclassified the others, without sacrificing the simplicity, but, on the contrary, adding to both the simplicity and definition of the system. Poëy classifies clouds as:—

1. Cirrus.
2. Cirro-stratus.
3. Cirro-cumulus.
4. Pallium.
5. Pallio-cirrus.
6. Pallio-cumulus.
7. Cumulus.
8. Fracto-cumulus.

"Of these, the first three and fifth are the higher clouds. The last three are clouds of the lower atmosphere."

Cirrus.—This is the most lofty of all clouds, appearing still at a great elevation, even when seen from the greatest heights of the Himalayas; and, as estimated by Fritsch,

probably never lower than 6 miles. It consists of crystals forming groups or brushes, parallel, diverging or curled, very thin, and always more or less fibrous in appearance.

Cirro-stratus.—Also a lofty cloud, but lower, denser and more sheet-like than cirrus. It is at such a height that it also consists of snow crystals, but is sometimes of such thickness as to dim the sun's disc, and even almost completely obscure it. When it does not extend over the whole sky, it thins off towards the edges; and when seen, as sometimes in the evening and morning, low down near the horizon, it presents the appearance of horizontal streaks which are often misinterpreted stratus. Its form is very variable, sometimes it appears as a uniform sheet, at other times as broken, undulated or fenestrated layers. It exhibits the phenomena of lunar and solar halos.

Cirro-cumulus.—Also a lofty cloud, which forms on the breaking up of pallio-cirrus. One common form of it is known as a mackerel sky, consisting of little rounded cloud-tufts, more or less regularly in ripple-like layers; often appearing after rain.

Pallium.—Consisting of the two following—

Pallio-cirrus.—A thick, but lofty, sheet of cloud obscuring the sky, and forming the upper layer of the pallium or rain-cloud. It is formed by the sinking and thickening of cirro-stratus.

Pallio-cumulus.—The thick mantle of cloud which constitutes the lower layer of pallium or rain-cloud. Formed by the rapid increase and coalescence of cumulus. It extends to greater heights than ordinary cumulus, but is [sometimes?] separated from the higher layer of pallio-cirrus by a cloudless intervening stratum. After rain, it breaks up and disperses more quickly than the higher pallio-cirrus.

Cumulus.—This is one of the most familiar and typical of cloud forms, and is characteristic of the lower atmosphere. In Bengal nothing is more common, after a fine morning in the hot weather, and especially during breaks in the rains, than to witness the formation, at no great height, of isolat-

ed masses of clouds with rounded summits and flat bases, all at about the same level. These are cumulus, and mark the summits of ascending columns of air, which reach saturation at the plane marked by the cloud patches; and, above this, deposit the excess of their moisture as cloud.

Fracto-cumulus. — The broken, irregular masses into which pallio-cumulus is resolved when in the act of breaking up, or into which it is driven by the wind. It is, therefore, like cumulus, a cloud of the lower atmosphere, and includes the torn masses commonly termed "scud."

384. **Cloud Symbols.**—In recording the cloud forms in the regular register, the following symbols afford a convenient abbreviated notation :—

C.	Cirrus,	Pc.	Pallio-cirrus,
Cs.	Cirro-stratus,	Pk.	Pallio-cumulus,
Ck.	Cirro-cumulus,	K.	Cumulus,
P.	Pallium,	Fk.	Fracto-cumulus,

the first letter being a capital, the second a small letter in the case of bi-literal symbols. The symbol P indicates that the sky is overcast, or nearly so, by a low sheet of cloud in or about the altitude of cumulus, and concealing all above it. When the sky is overcast by a sheet of very elevated cloud, this may be either cirro-stratus or pallio-cirrus, the latter being the lower and denser of the two.

Movement of Clouds.—This subject deserves more attention than has hitherto been given to it in India.

There is but little difficulty in observing the direction of the movement; but, like other kinds of observations, if it be attempted as a mere matter of routine, and without some care and attention, the register is likely to be so erroneous as to be only misleading and worse than worthless. In recording the direction of the cloud movements, the kind of cloud on which the observation is made, whether cirrus, cirro-stratus, fracto-cumulus, or other, should be noticed by its appropriate symbol. This is necessary, since the kind of cloud observed affords a rough indication of the elevation to which the observation relates.

385. Beaufort's Initials:

b.—Blue sky ; a cloudless sky : whether clear or hazy.

c.—Clouds ; either for clouds in detached masses, or in sheets with openings. Not to be used when the sky is overcast.

d.—Drizzling rain.

f.—Fog. Except among hills and in the cold weather in the damper parts of India, this symbol will not be much used. It is not to be used for mistiness, but only for such fogs as form over damp places in the evening.

g.—Dark, gloomy weather.

h.—Hail.

l.—Lightning. Not to be used for the flashes that are sometimes seen to illumine the sky low down near the horizon. These, if noticed at all, may be entered as l. r. (lightning reflection).

m.—Misty, dust haze. To be used for the dust haze so common throughout the dry season in the interior of India (and also at the Sandheads in the earlier months of the summer or S.W. monsoon).*

o.—Overcast. To be used when the sky is completely covered with pallio-cirrus or pallio-cumulus.

p.—Passing temporary showers. Not for north-westers and similar storms, but for the case when showers, lasting for a few minutes, succeed each other with fine intervals.

q.—Squally.

r.—Continued rain.

t.—Thunder.

u.—Ugly, threatening.

v.—Visibility ; referring to distant objects, this symbol is very frequently misused. It has reference to the transparency of the atmosphere, and indicates that the details of distant objects can be seen with unusual distinctness. On the plains of India such a state is rarely experienced

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* The sentence in brackets is by the Author of this work.

except either immediately before, or immediately after, rain.

w.—Wet, for dew.

A bar (—) under any of the above weather initials augments its signification; thus t heavy thunder, r much and heavy rain, or $\underline{\text{r}}$ heavy and continuing rain. The force of the wind is denoted by the numerals, and is generally roughly measured at sea by the amount of sail which can be carried when close hauled; and is graded from 1 light wind, to 12 hurricane wind of the cyclone.

THE HOUSES OF REFUGE.

386. The following are the instructions to wrecked seamen and others who may reach the Houses of Refuge in distress, and which are posted up in them in three or four different languages.

"Provisions, water, clothing, and certain other stores, as per list marginally noted, have been placed in each Refuge House for the use of shipwrecked people. It is requested that the greatest economy be observed in the use of them; and that in case of all the stores in this house not being required, whatever may be left, be packed and carefully covered up again. It frequently happens that the stores in the Houses of Refuge are robbed by wood-cutters and boatmen, so be most careful with what provisions you take with you if journeying from one Refuge House to another.

List of stores supplied to each Refuge House—

- 1 cwt. of biscuits in four sealed tins.
- 6 flannel shirts.
- 6 cloth trowsers.
- 6 country blankets.
- 6 pairs of boots.
- 6 straw hats.
- 4 tin pots.
- 1 tin lantern.
- 2 lbs. of candles.
- 5 lbs. of nails.
- 2 coal chisels.
- 2 hammers.
- 2 gimblets.
- 2 flints and steels and solah for tinder.
- 4 boxes of matches in tin boxes
- 15 feet of canvass hose.
- 24-lb. tins of soap.
- 2 axes.
- 60 fathoms 1½-inch coir rope.
- 1 catamaran.
- 2 paddles.
- 2 bamboos.
- 1 chart in tin case, with tight fitting lid; also a set of instructions in English and French.
- 100 gallons of water in tanks.

Refuge Houses Nos. 2 and 5 have two catamarans and two sets of paddles.

The party should be kept together, and no one allowed to stray, as tigers are numerous.

Make a fire as a signal of distress with the driftwood generally to be found all along the sea-face of the Sunderbunds and banks of the rivers.

After cyclones and heavy gales, Government despatch a steamer to visit the Refuge Houses; therefore under such circumstances, unless you have boats, it will be advisable to remain by the Refuge until assistance arrives; but in cases where vessels have been lost in ordinary weather of either monsoon, it will be advisable to send notice to Mud Point, Saugor Island, or Canning Town (River Mutlah) or to vessels entering the river (as may seem best), by the catamaran with which each House is provided, if no better mode of conveyance is at hand. The chart will indicate the route to be observed.

Should you decide to leave the House, keep together, and follow, as much as possible, the large creeks,* or sea beach, going from one House to another if necessary, until you come to Channel Creek (if going to the westward), where there are villages on Saugor Island, visible from Refuge House A. To the eastward, villages will be found above the Cattalee, on the River Mutlah, if you decide on proceeding to Canning Town.

On your road, break the branches of trees (allowing them to hang), to indicate to those who may be in search of you the direction you are going in. If travelling to the north, break the branches on the north side of the trees; if to the west, those on the west side, &c. Be careful to do this at all points and at the entrances of creeks that you may pass. Carry fire with you; it will be useful in many ways, and enable you to make signal (and tiger-scaring) fires at all stopping places as you go along.

The rope placed amongst the stores is intended to assist in making a raft, or for tracking purposes. Driftwood in large quantities is often found, and among it may sometimes be found material for forming a raft if required.

In case the provisions have been stolen, the hearts of the young palm trees, which grow in great numbers, will be found edible. The scurvy grass or samphire, which grows in great quantities, is also edible when cooked.

* *See* p. 263.

Water can be procured at No. 1 House by digging down a few feet on the higher parts of the land, and there is every probability of water being found in many parts of the Sunderbunds at short distances from the sea, particularly on the higher lands, such as the west of Bulcherry and Bangadonee Islands, &c., &c.*

A sheet has been attached to the roof of the house for the purpose of catching water and the hose, supplied among the stores, is intended to enable you to save water when it rains, and refill the tank, before leaving the house.

H. HOWE,
Offg. Master Attendant.

MASTER ATTENDANT'S OFFICE;
CALCUTTA,
28*th March*, 1871.

* My late lamented brother used to tell me, after he had been cast away in 1868, that, on landing from the raft on the seaface of the Sunderbunds, and near the mouth of the Hurringotta river, the native woodcutters, whom they providentially fell in with, showed them how to appease their thirst by plucking from some jungle plant a fruit or seed something like a *pine cone*, and that, on breaking the bulbs of which it was composed, a few drops of water were gratefully dropped on their parched tongues. I would thank any one for its native name. —S. R. E.

THE REFUGE HOUSES DESCRIBED.

387. **Refuge House A,** Lat. 21° 43′ 25″ N., Long. 88° 13′ E., is eight miles N.N.E. from Sidney Point, the S.E. extremity of the western division of Saugor Island, about the same distance, N. ½ E., from Pitt's Point (all as the crow flies). It is erected on the eastern or left bank of the Burra Tollah river or Channel Creek, and well inside on the northern bank of the mouth of a creek which going southward traverses this eastern division of Saugor Island (353); and which works its tortuous way down to the eastward of Pitt's Point opening out on the estuary of Channel Creek, within three or four miles north of, and on the same coast line as No. 1 Refuge House.

The A Refuge is only two miles south of the west entrance to the Doar Agra River running eastwards as a connecting navigable channel between the Subtermooky river and Channel Creek, and through which there is much traffic, some one of the I. G. S N. Company's vessels being generally on its way through every day.

Refuge House No. 1, Lat. 21° 32′ 25″ N., Long. 88° 14′ 45″ E. On Seyer Point just to the northward of Jackson's Grove, a grove of tall trees which bear from Lower Gasper Light Vessel, N. 46° E., distance ten miles (see 171), and 3¾ miles S.E. by S. from Pitt's Point on the western shore of the eastern division of Saugor Island facing the estuary of Channel Creek; is erected on a small plain covered with short grass.

Refuge No. 2, Lat. 21° 43′ 25″ N., Long. 88° 13′ E., erected on the eastern or left bank of the easternmost of the two mouths of the Subtermooky River, and to the eastward of the tail of Lothian Island which separates them. It is on that part of the coast line which faces the west, but which, to the southward of it, trails away round S.E. for 3½ miles forming a point at the mouth of a creek

4½ miles W.N.W. of the S.W. extremity of Bulcherry Island and Refuge House No. 3, erected there:—A point that is environed, as is most of the land of the Soonderbunds, with sand-banks and flats—a point, off which, the waters of the Subtermooky River running S.E. unite with those of the Jumerah River running S.S.W., and then follow down in the general S.S.E. direction, forming a deep water channel to the sea between the Lighthouse or Subtermooky Sand on the west, and the Bulcherry Sand on the east; a channel with not less than 5 fathoms, with (as in all the channels west of the Argo Flat) deepest water on its eastern side.

It is N.E. by E., 8¾ miles, as the crow flies, from Refuge House No. 1, and 4 miles from the land; on this rhomb line, on the western side of the mouth of the western arm or branch of the Subtermooky River, this line crosses the flats off the S.E. part of Lothian Island after it leaves the western or right bank of the Subtermooky River. It is S.E. 9 miles as the crow flies (which is right across the extreme N.E. end of Lothian Island) from the eastern end or mouth of the Doar Agra, where it debouches on the west or right bank of the Subtermooky River: and S. ½ E. 3½ miles from the navigable creek next above, to the northward of that small one close to the southward of which it is erected: and which creek or canal runs up N.N.E. for 7 miles and leads into another large one running E. and W., through which there is probably some traffic as it connects the Subtermooky and Jumerah Rivers.

Refuge House No. 3. Lat. 21° 32′ 30″ N., Long. 88° 28′ 45″ E. Bears from Refuge House No. 2 S.E. ⅝ E., 7 miles, as the crow flies: from Refuge House No. 1, E. ¼ N., 13 miles, and from the nearest point of land west of the confluence of the two rivers, the Subtermooky and the Jumerah, E. ¼ S., 7½ miles. It is 400 yards north of the westernmost part of Bulcherry Island, at the east side of the estuary of the Jumerah River, and abreast of the con-

fluence of the two abovenamed rivers, also close to the southward of a creek running N.E. through this island and which leads into a large creek running generally N.W. and S.E., connecting the Thakooran or Jumerah River with the Mutwal or Roy Mutlah River.

Refuge House No. 4. Lat. 21° 32′ 30″ N., Long. 88° 44′ E. Stands on the south point of Dalhousie Island on the east side of the mouth of the Mutwal or Roy Mutlah River, 3½ miles S.E. It is E. ¼ N., 15 miles from Refuge House No. 3, and on the same bearing 8¾ miles from the easternmost point of Bulcherry Island; and is about half way between the mouths of the Mutwal or Roy Mutlah River to the westward and the Bangadooney River to the eastward, and is on the seaward part of the island.

Refuge House No. 5. Lat. 21° 32′ N., 88° 49′ E. It is 100 yards above high water-mark and just above a small sand-bank; it is distinguished by a pole with basket. It is on the easternmost side of the mouth of the Bangadooney River, and is 4½ miles east of Refuge House No. 4. This the last and easternmost of the Refuge Houses, and lies N. ¼ E., 28½ miles from the Mutlah Light Vessel.

The houses are all of the same construction and are painted white, and have each a long mast with a basket beacon upon it to mark them when hidden from view by jungle.

Tracks from the Refuge Houses towards Mud Point Telegraph Station on the eastern side of the mouth of the Hooghly River, on the extreme north end of Saugor Island, and at the western entrance or end of the Burratollah River or Channel Creek.

From Refuge House No. A. Follow up channel creek passing the entrance to the Doar Agra River on the east then away N.N.W. following round the N.E. side, and N.W. round the north end of Saugor Island to the Electric Telegraph Station at Mud Point.

From Refuge House No. 1. Follow for a distance of 4 or 5 miles through the first creek to the northward of the Refuge House, which brings you out on the Subtermooky River opposite to an island called Lothian Island; then north up the western and main branch of this river for 3½ miles to a small creek on its right or west bank, after passing which follow N.N.W., 4 miles, to the junction of the two branches of this river at the north end of Lothian Island and the junction of the Doar Agra River with it; and still keeping the land aboard on the left or west side, follow N.W. about 6 miles through the tortuous course of the Doar Agra River, till the Burratollah River or Channel Creek is made, then on as directed from Refuge A. If there is fine weather and smooth sea, of course, the shortest and most convenient route will be direct N.W. up the estuary and mouth of the last-mentioned river, past Pitt's Point on the east or starboard hand, and Sidney Point (the S.E. extremity of the western division of Saugor Island) on the west, and then north up the course of this river till falling in to the last given track as it emerges from the Doar Agra River.

From Refuge No. 2. If the weather is fine and sea smooth, cross over to the westward round the south end of Lothian Island and the flats off its southern extremity, then up the western branch of the Subtermooky River and onwards as the last track; but the shortest and safest route will be, north, up the eastern, though narrower, arm of the Subtermooky River, keeping the land aboard on the right hand opposite to Lothian Island and the shoals off it, until you have rounded its northern extremity: during which course the mouths of three creeks on the right hand side will be passed, the first 1 mile north of Refuge House No. 2; the second 4 miles, and the third 6½ to 7 miles in the same direction after leaving the Refuge House. After rounding the north end of Lothian Island, 2 miles at first W.N.W., to clear the tail of a central sand, and then N.W., will take you across the Subtermooky River right into the mouth

of Doar Agra River; then on as directed from Refuge House No. 1.

From Refuge House No. 3. Enter the creek close to the northward of the House and follow on N.E. through Bulcherry Island, 4 miles, when the large creek running in a general direction N.W. and S.E., connecting the mouth of the Mutwal or Roy Mutlah River with the Thakooran or Jumerah River, will be reached at the back or lee side of the island. Then turn west and N.W. for another 4 miles, until the north end of Bulcherry Island is reached, when you will be in the last-mentioned river, which has a breadth here of 3 miles: this follow up N.N.W. for 8 miles: (keeping the land on the starboard, eastern, or right hand side aboard) when, after passing two or three creeks, a bend of the river is come to, and you turn off to the N.E. and then N.N.E. for 5 miles, when you arrive at the entrance to a large creek, which runs away S.E. and connects this river with the Mutwal or Roy Mutlah River: and here, still keeping on the right hand side or left bank of the river, you turn off from this creek N.W. between a small island on your left and a creek on your right, 1½ miles above where the river changed its course, and the large creek leading to the Mutwal River: and after going another 2½ miles, strike off N.W. diagonally across the river (which here turns again to the north); and, just below a small island near the right or western bank of the river (here 1 mile broad), you find a large creek opening out on it from the westward, which creek follow at first west and then W.N.W. for 3½ miles, when you will enter another small river or creek running S. and S.W. across it: turn down this small river 8½ miles in its S.W. and S.S.W. course. (About 3½ miles up to the N.W.W., on the east or left bank of this small stream, lies the village of Khooroopara, and there are several other villages hereabouts.) You come then to a creek branching off to the east and which connects this stream with the Thakooran or Jumerah River, but which is not navigable, or much

distance would be saved instead of going so far north about. At this connecting creek the stream turns away to the westward, crossing the entrance to another large creek, or rather the continuation of the same small river which we have been coming down S.S.W. on; this is about 1½ miles from the last creek which turns so sharply off to the eastward. Leave this stream, which we find by the chart has its mouth facing the north end of Lothian Island, and follow west for 1 mile, when a creek on the right or north bank marks the point where the course of the stream turns away left or S.W., and at a distance of 3 miles you find yourself in the Subtermooky River, having a breadth of 1¾ miles, at a spot where the river changes its course from E.S.E. to South or S. ½ E.; here you follow down for 4 miles close to the eastern or left bank of the river between it and a long sandbank, when you join the track from Refuge House No. 2, and strike across the river W.N.W. and N.W. towards the confluence of the Doar Agra River with it.

Of course, very much distance would be saved if sea and weather permitted the possibility of weathering the tail of the flat off the south end of the land on which Refuge House No. 2 is erected, and so to fetch into the Subtermooky River.

From Refuge House No. 4, you either follow N.E. 4 miles through a creek, which opens out about 1 mile west of the Refuge House, and which creek intersects (with two others which it joins on its way) the southern end of Dalhousie Island and opens out at the mouth of the Bangadooney River; or follow round the S.E. sea face of the island and N.N.E. up the estuary of the Bangadooney River between Refuge House No. 5 and Bangadooney Island, on which it is erected, and Dalhousie Island, and round its S.E. extremity and N.W. up the mouth of the Bangadooney. Following up the Bangadooney River N.W. for 2½ miles, and passing the large creek through which is the bad weather track, its course turns off to the N.N.E.: but, crossing over N. by W. 2½ miles to the N.E. shore of Dalhousie

Island, the mouth of Dalhousie River is come to, which enter, and after going N.W. 8 miles, you come to the Mutwal or Roy Mutlah River, running S. by W., $3\frac{1}{2}$ miles broad.

Port Canning, which has rail communication with Calcutta, is 40 miles north of this point.

After leaving the Dalhousie River the same course is shaped diagonally across the Mutwal River, and you will fetch into another connecting creek, which, for the first 2 miles, runs on the same course, N.W. It then takes a turn for another 2 miles W. by S. till another creek is reached, leading away to the southward, when it gradually assumes a course more northerly (N.W. by W.); passing another creek on the left or south hand: there are also three creeks on the right or N. E. hand of this connecting creek, each about $1\frac{1}{2}$ miles apart, the third one 3 miles from the S.E. entrance to this creek or from the Mutwal River.

At a distance of 2 miles, after leaving this last creek on the right or starboard hand, the track will be found to open out on the east or left bank of the Thakooran or Jumerah River, at its turning point where its course alters from S.E., to S. by W., here 2 miles broad, and at the point where the track from Refuge House No. 3 passes, which follow.

Nearly the whole of the land eastward and westward of the lower part of the Mutwal or Roy Mutlah, is solitary jungle and swamp infested with tigers and other wild animals, and all the creeks and rivers, even from Balasore right across to Chittagong, swarm with sharks and crocodiles, some of them immense brutes and very voracious.

From Refuge House No. 5 the track lies up N.N.E. through a creek close to the westward of the House, and which runs east and S.E. round the islet on which it stands, and then through a small creek (which branches off N.N.E. at 1 mile E.N.E. from the Refuge House) for a distance of 4 miles (the breadth of Bangadooney Island); coming out at the estuary of the Guasaba River and the confluence of a large connecting creek with it, running E.S.E. from the

mouth of the Bangadooney on the lee or N.E. side of the island; you then turn to the W.N.W. 6 miles, following round the north side of Bangadooney Island: and, joining the tracks last given from Refuge No. 4, turn up the Bangadooney River to the north, cross it and enter the mouth of the branch stream from the Mutwal or Roy Mutlah River, and so on as directed before.

Here again, if the state of sea and weather permits, the track up the weather or western side of Bangadooney Island, between it and Dalhousie Island on the west, may be taken for a run of 4½ miles, as was given for the fine weather track from Refuge No. 4, by which much distance will be saved.

It is high water on full and change days at this part of the sea face of the Sunderbunds at between 10 and 11 hours, according as you are far inshore or not; also there is a rise and fall in the springs of 10 to 12 or 14 feet and in the neaps of 6 to 10 feet. The current runs strong through some of the creeks, the flood tides generally from some easterly direction, and the jungle generally grows close down to high water-mark.

The southerly swell in the height of the S.W. monsoon breaks a long distance off dry land, but must, of necessity, be encountered before a landing can be effected.*

* My lamented brother, John Harris Elson, with Captain Bower of the "Sultana," wrecked on the Roy Mutlah (when waterlogged), Mr. Copeland, Mutlah Pilot, and four natives of India spent eight dreary days on a raft without food or drink in August, 1868: and his experience of the heavy rollers that broke over them as they crossed each sandbank on their 80-mile drift from the Roy Mutlah Sand to the eastern shores of the estuary of the Hooringottah River, was shown in his often-repeated remark to me: "Samuel, if ever you are cast away in the South-West monsoon on the sea-face of the Soonderbunds, and have the choice between a raft and a boat, you take to the raft, for a boat would never live in the heavy breakers which lash its shores." Nor evidently had he forgotten this experience when, at the Sandheads on the 29th June, 1872, as pilot of the fast foundering ship "Rothsey," with the few shreds of canvas she had left, he made tracks for Balasore Beach to the westward, anchored her in 5 fathoms, rigged, and successfully launched a large raft, on

Yet it must not be forgotten that shipwrecked crews have been saved in their own boats in the South-West monsoon: for instance, the crew of the ship "Lady Belhaven," wrecked on the "Argo Flat" during the South-West monsoon of 1879: but who were favoured with an extraordinary long run of fine weather, so that one boat actually pulled across to the Gasper Channel at the south end of Saugor Island, and another pulled to the Mutlah Light Vessel, a distance of 80 or 90 miles and 45 to 50 miles respectively. And here the advice about taking boats through a surf as set forth in Bedford's Sailors' Pocket Book, would prove invaluable to castaways in boats, and every sailor who sees so little of boating now-a-days, would do well to study this part of his profession; not knowing how soon he may want to put the theoretical knowledge he might glean from this above named, and other books, into desperate and earnest practice.

All the tracks from the different Refuge Houses, as given above, are those by which, at this date, 1881, searching and relieving parties would be sent in steam launches; so they should be followed by those seeking relief if they elect to move from the Refuge Houses at all.

which 15 souls left her, and who doubtless would all have been saved had they not had to contend with the small, but prolonged, cyclonic storms which raged with violence for three days over the head of the Pilot's Ridge and Balasore Roads. As it was, nine of the poor fellows hung on to it, and so fetched the shore: but my brother, exhausted and worn out, succumbed to the curling breakers near the beach, and was drowned on the morning of the 2nd July, the second day after leaving the ship.

POSITIONS, &C., OF OBJECTS.

388. TABLE OF LATITUDES AND LONGITUDES, TIMES OF HIGH WATER ON FULL AND CHANGE DAYS AT, AND DISTANCES IN GEOGRAPHICAL MILES OF, THE SEVERAL OBJECTS FROM CALCUTTA.

Names of Places and Objects.	North Latitude.	East Longitude.	Times of High Water.	Distance from Calcutta.	Index number.
False Point Lighthouse...	20° 20′ 20″	86° 44′ 00″	8h. 30m.	200·0 mls.	323
Palmyras Reef Buoy ...	20 41 45	87 12 00	......	166·1 „	319
Pilots' Ridge Light Vessel	20 49 15	87 39 15	9 16	139·6 „	312
Kannaka Buoy ...	20 50 00	87 04 00	......	162 „	313
Balasore Buoy ...	21 24 00	87 06 00	8 00	159 „	224
Western Sea Reef Buoy...	21 09 30	87 56 25	9 5	113* „	259
South Channel Buoy ...	21 00 30	87 58 30	9 00	123·8* „	296
Eastern Channel Light Vessel ...	21 01 19	88 13 00	8 54	122·75 „	286
Mutlah Light Vessel ...	21 04 00	88 46 30	9 00	152 „	276
Lower Reef Buoy ...	21 06 25	88 07 30	9 00	117·5 „	266
Lower Saugor Sand Buoy	21 08 45	88 14 30	9 6	115 „	254
Intermediate Light Vessel	21 14 00	88 11 20	9 18	108·25 „	238
Intermediate Station Buoy	21 13 00	88 10 00	9 20	109 „	244
Bell Buoy ...	21 18 00	88 07 45	9 24	102 „	209
Centre Saugor Sand Buoy	21 18 45	88 11 35	9 28	104 „	206
Lower Gasper Light Vessel	21 26 15	88 06 38	9 38	96 „	166
Upper Gasper Light Vessel	21 31 00	88 02 53	9 45	90·25 „	127
Saugor Anchoring Buoy...	21 34 00	88 00 30	9 50	86 „	93
Saugor Lighthouse ...	21 48 43	88 02 00	10 00	81 „	54
Cowcolly Lighthouse ...	21 50 00	87 56 00	10 15	70 „	

* *Viâ* Western Channel.

NEW METHODS OF SIGNALLING NIGHT AND DAY.

389. On Sound and Visual, Time, or Flashing Signalling.

I remember as long ago as 1854-5, during our war with Russia, how well the allied British and French squadron were kept together during two or three days of almost continuous fog, when we were cruizing in company in the gulf of Tartary, by time sound signalling, made with the properly timed intervals between the reports of 68 pounders fired from the flagship of the British Admiral: and have always, since the introduction into the Royal Navy of Colomb's Flashing Signals, wondered that this simple mode of time signalling has not been extended to the mercantile marine of all nations, especially so, since there is a book of signals, the International Code, to which it can be so easily applied. It was .to supply such a want, as some simple means of communication between vessels of all nationalities by night, in fogs, and under other circumstances when flags are not available for the purpose of making wants known, that three years ago I printed and circulated my little pamphlet, The Morse Universal Marine Flashing Signals: and also reprint it here under the more significant name of The International Code Sound and Visual, Time, or Flashing Signals. It so happens that the Morse alphabet has amongst its symbols nineteen only, which consist of both dots and dashes,—shorts and longs—all the others consisting entirely of either dots or dashes, and, consequently, not so well adapted for our purpose: which is, to make signals, which those who have never seen or heard of the system before, or who would seldom have use for it, may be able to read and comprehend with ease; for, with a symbol consisting entirely of shorts or entirely of longs, there may be some doubt in the minds of the receivers of the signal as to whether the flashes of light, &c., were intended for either

the one or the other : whilst there could be no doubt about the comparative length of the flashes or exposures of light, &c., when each symbol contained both the one second or short flash, and also the four second or long one : and as there are just nineteen flags in the International Code of Signals, these nineteen symbols of the Morse telegraphic alphabet answer our purpose most admirably : so much so, that I have, whilst lying at anchor in the river, made by these means, signals by night, with willing co-operators Messrs. Arden, Hubbard, and Stone,—masters of tug steamers, who were entire strangers to the plan, until I had provided them with the nineteen requisite characters or symbols beforehand : and have been understood and answered by them with another full signal, to the amusement and satisfaction of the shipmasters on board whose vessels I happened to be at the time.* The only apparatus I had in use, being the ship's binnacle light and my sola topee or sunhat to serve as a screen, whilst I counted the 'one,' 'two,' 'three,' 'four,' corresponding to the dashes; and the 'one' corresponding to the dots of the symbols, as I lifted the hat and exposed the light to view in accordance with the rules laid down.

For those who have more frequent opportunities of putting the system in practice, and who have attained to that proficiency which enables them to spell the message "right through, letter by letter, and word by word," I have inserted the Morse system as it is published in the Bengal Pilots' Code of Signals, Trinity House Manual; and, in fact, known in all electric telegraph offices of the world.

The International Code pennant sign or symbol ||..||.., &c., made, should doubts arise, will prevent confusion as to which code is being used : and besides, a signal from the International Code will consist of only two or three symbols,

* The Telegraph Master at Diamond Harbour, on our first trial, declared it to be the most simple and perfect plan that could be devised for night-signalling with merchant vessels.

whilst the absence of the vowels e, i, o, without which few words are spelt, must show at once which Code is meant.

The best lanterns I know of for night flashing or time signalling, are those used by our army in India, and I believe known as Major Begbie's Flashing Lanterns, the shutter of which consists of a number of narrow thin pieces that open and shut simultaneously on the touch of a spring, like the pieces of a venetian blind.

390. THE INTERNATIONAL CODE SOUND AND VISUAL, TIME, OR FLASHING SIGNALS.

By night—with long and short flashes from a single lantern.

By day—for very distant signalling, by means of lowering and hoisting the upper sail on the main mast; or the weather clew only if a square sail; or by means of dipping and hoisting one large flag, for instance the ensign: keeping the sail or flag down for long or short periods of time as required to express the dashes or dots of the Code; or if using the weather clew of the upper square sail, it should be kept up for the same periods: and the sheet hauled home, as sail or flag are hoisted, for a sufficient time to express the required intervals. In these two cases the 14 or 28 seconds log-glass would be useful to measure the times and intervals by.

And where the flags of the International Code cannot be conveniently hoisted and for short distances, by means of long and short puffs of steam from a steam pipe, and by means of long and short waves of a flag, hat, handkerchief, &c., &c. *Note*—The long and short waves may be well understood, by supposing the flag and staff, or arm, &c., to be the arm of a clock, and waving it from, say, the ten to the two for the short wave, corresponding to the dot of the Code; or prolonging the wave, to, say the five for

the long wave, corresponding to the dash of the Code, bringing the arm or staff immediately back again to the ten, after each long or short wave. It matters not if the flag is waved the reverse way (as the direction of the wind may often make it necessary so to do), that is to say, from the two to the ten, or seven respectively.

Or by guns:—Firing a signal gun as preparative to start and note the times and intervals from. The intervals between the dashes and dots being represented by the reports of the guns—the dash by an interval of thirty seconds, and the dot by an interval of ten seconds between each gun. The number of seconds elapsing between each letter symbol to equal double the number which elapse between the two guns denoting a dash of the Code or one minute; and the number of seconds elapsing between a repetition of a gun signal to equal the time which elapsed whilst making the signal.

Also this means of communication will be invaluable to the Mariner in thick or foggy weather,—making the symbols required, by sounding the steam whistle, foghorn, or bell, with the proper times and intervals of silence. *Note* —A treble ring on the bell denotes a dash, and a double ring a dot of the Code.

Thus, in a fog, when either at anchor or underweigh, vessels may, by sounding the two required compass letter symbols taken from the compass table of the International Code Signal Book, indicate the desirable information of "how they are heading," without interfering in the least with the present fog signals ordered to be used; or with either of the three optional sound signals proposed for the use of steamers, and which were very wisely commented upon in "Mitchell's Maritime Gazette" of the 22nd March of this year (1878).

The symbols are, with four necessary transpositions, those comprising the Morse Alphabet, and these transpositions are made so that each letter symbol shall be a combination

of both long and short flashes, whereby their comparative lengths can be the more readily distinguished, the would-be discarded symbol A being substituted for the symbol H, the U for the M, the X for the S, and the Y for the T. The Morse symbol Z is taken for the Code or Answering Symbol, which, like the Preparative Symbol, is to be repeated continuously (without break or pause, after each repetition), until it is seen and recognized by the other observer.

Three additional symbols—the C inverted, the J inverted, and the Z inverted—are given for any private or special use.

Symbols and Corresponding Letters or Flags.

— · · ·	B	· — ·	R
— · — ·	C or Yes	— · · —	S
— · ·	D or No	— · — —	T
· · — ·	F	· · · —	V
— — ·	G	· — —	W
· —	H	— — · · — — · · &c., &c.,	Answering sign.
· — — —	J		
— · —	K		
· — · ·	L	· · · · · · · · · &c., &c.,	Preparative Sign.
· · —	M		
— ·	N	· — · —	* Private or Special.
· — — ·	P	— — — ·	* Private or Special.
— — · —	Q	· · — —	* Private or Special.

The comparative lengths of the dashes and dots in the above table give the comparative lengths, respectively, of the long and short flashes of light, long and short duration of sound, &c.; and the spaces between them give the intervals of darkness or of obscuration of the light from the flashing lantern; of silence between two blasts of foghorn,

* Or for the X, Y, and Z, respectively, of the Bengal Pilots' Code of Signals.

steam-whistle, or double and treble rings of the bell; and of rest between two waves of flag, hat, handkerchief, &c., &c.

The long flash should be four times as long as the short flash, say, four and one seconds respectively.

The intervals between the flashes composing a letter symbol should be equal in duration to a short flash.

The interval between any two letter symbols in a signal group should be equal in duration to a long flash.

The interval or pause between any two repetitions of a signal group should be equal to one-third of the whole time taken in making the signal.

The signal should be repeated with the same measured flashes and intervals, until the answering symbol—a continuation of double-long and double-short flashes (certifying that it has been carefully read and its import perfectly understood)—has been observed for a sufficient time to ensure certainty, and no fresh signal is to be commenced until the answering signal ceases to be made to the last group of letter symbols shown.

Whilst the message is being sent, the receiver should keep his light exposed and directed towards the sender, and on making out the group of symbols sent should darken his light for a short period, say, one or two seconds, to intimate to the sender that he is now searching the signal book for its import, which, if understood, should be signified by the answering sign provided; but if not so understood, and another repetition is required, his light should be obscured altogether till the sender begins to repeat the last group made.

Precautions.—Do not begin exposing or flashing the light until you are sure no other light such as lights below, carelessly left to shine through ports, shows from your vessel in the direction you wish your signal to be seen, of course, excepting the coloured sidelights. But care must be

taken to ensure the brighter flashing light being sufficiently removed from them so as not to eclipse them.

Do not be in a hurry, for, remember, that on the regularity with which you time and make the proper exposures and obscurations, depend the successful reading of your signal.

An Example of Night Signalling.

Where A and B are two ships in company, say, at the Sandheads, off the mouth of the Hooghly River :

A begins to flash a light at short intervals towards B ; thus, ▬ ▬ ▬ ▬ ▬ ▬ &c.
Preparative.

Continued (without break or pause), until answered from B by the double-long and double-short flashes ; thus, ▬▬▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬▬▬ ▬ ▬ &c.
Answering.

Continued (without break or pause), until the preparative ceases to be made by A. Then A (after the answering flashes cease) makes

▬ ▬ ▬▬▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬▬▬ ▬ ▬
M S L pause,
▬ ▬ ▬▬▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬▬▬ ▬ ▬
M S L pause,
▬ ▬ ▬▬▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬▬▬ ▬ ▬
M S L pause, &c.

meaning "What is the bearing and distance of."
Answered by ▬▬▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬▬▬ ▬ ▬ &c.
Answering.

Then A continues

▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬▬▬ ▬▬▬
L S W pause,
▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬▬▬ ▬▬▬
L S W pause,
▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬ ▬▬▬ ▬▬▬
L S W pause, &c.

meaning "Floating Light."
Answered by ▬▬▬ ▬▬▬ ▬ ▬ ▬▬▬ ▬▬▬ ▬ ▬ &c.
Answering.

B then begins with - - - - - - &c.
Preparative.

Answered by — — - - — — - - &c.
Answering.

Then — — - — - - — - - — -
G S F pause,
— — - — - - — - - — -
G S F pause,
— — - — - - — - - — -
G S F pause, &c.

meaning "12 hours or midnight."

Answered by — — - - — — - - &c.
Answering.

Then - — - - — - - — - —
L S H pause,
- — - - — - - — - —
L S H pause,
- — - - — - - — - —
L S H pause, &c.

meaning "At (time indicated) light bore."

Answered by — — - - — — - - &c.
Answering.

Then — - — - — - - -
O B pause,
— - — - — - - -
O B pause,
— - — - — - - -
O B pause, &c.

meaning "North."

Answered by — — - - — — - - &c.
Answering.

Then - - - — - — — - — -
V W R pause,
- - - — - — — - — -
V W R pause,
- - - — - — — - — -
V W R pause, &c.

meaning, "Ten."

Answered by — — - - — — - - &c.
Answering.

Then
— - - - — — — - — — - — -
D J W R pause,
— - - - — — — - — — - — -
D J W R pause,
— - - - — — — - — — - — -
D J W R pause, &c.

meaning "miles from or distant."

Answered by — — - - — — - - &c.
Answering.

The sender also flashing the answering sign or symbol signifies that he has finished.

Fog Warning Signals—Example.

With regard to the Fog Warning Signals it is to be observed that, in consequence of the flags or symbols being so suitably arranged in the Compass Table of the International Code Signal Book, the given seventeen Morse symbols have only to be learnt by heart to enable the anxious mariner to dispense with the use of the Signal Book altogether, when interpreting the meaning of the two letter symbols, which he hears sounded on the foghorn or steam-whistle of an approaching vessel, as a glance at the Compass Table itself will show.

For, supposing, with the wind at North : A, close hauled on the port tack, hears two or three points on his starboard or lee bow, B's two compass symbols — — - (G) - — (H) sounded on the foghorn: he knows that the first symbol 'G' denotes that B's head is in the last of the four quadrants, that is, between West and N. ½ W. And by the second symbol 'H' he knows he must add four half points to the right of West, because 'H' is the fourth flag (omitting the G) from 'G B'—West. So that B's head must be W.N.W., and, as the wind is North, A knows B must be close hauled on the starboard tack; and, as the rule of the road directs, he immediately bears up to go under B's stern, with as much confidence as if he could see the vessel.

In like manner B, who is close hauled on the starboard tack, hears A's warning signal — - — - (C) - — - (R) on the foghorn about two or three points on his lee or port bow, and knows at once by the first symbol 'C' that A's head

is in the first of the four quadrants, that is, between North and E. ½ N. And by the second symbol 'R' he knows he must add twelve half points to the right of North, because 'R' is the twelfth flag or symbol (omitting the 'C') from 'C B'—North. So that A's head must be E.N.E., and as the wind is North, A must be close hauled on the port tack. Therefore, in compliance with the rule of the road, he keeps his luff, knowing it is A's duty to get out of his way.

Notes.—That the present law may be complied with, the single or double blasts denoting what tack a vessel is on, and the three blasts denoting the wind to be abaft the beam, may be sounded between each repetition of these two compass symbols.

When the first symbol consists of three blasts, the course of steamer or ship must, of necessity, be between East and S. ½ E., or in the opposite quadrant; and when it consists of four blasts, the course must, of necessity, be between North and E. ½ N., or in the opposite quadrant, that is between South and W. ½ S.

When the wind is near one of the cardinal points of the compass, the first symbol of the two, sounded by the ships on opposite tacks will, of necessity, be different as regards the number of blasts of the foghorn—the one being three, and the other four blasts.

To teach the look-out man to blow the horn with the proper long and short blasts, and to make the short intervals between the blasts, and long intervals between the two symbols, a good plan would be to chalk the symbols on the forecastle head for him to look at whilst blowing it.

Twenty-one Single Letter Symbols for signalling the most common messages used between Ship and Steamer, when towing by night, and the state of the weather precludes the vocal message being heard,

Made either by flashing a light; by sound blasts from a whistle, &c., &c.; or both light and whistle, flashed and sounded simultaneously (and as the one corroborates the other, perhaps this is the safest plan), using, if the exigencies of the case require it, the same Preparative and Answering symbols as before.

For the exclusive use of the Steamer which is towing, seven other suitable messages are given below as substitutes for those marked with an asterisk :—

B — · · ·	*	Go slow. Ease down.
C — · — ·		Affirmative. Yes.
D — · ·		Negative. No.
F · · — ·		All fast. All right.
G — — ·	*	Go on. Full speed.
H · —		Hold on (hawser or line).
J · — — —	*	Will you take my pilot out?
K — · —		Slack away. Tow with more scope.
L · — · ·		Send a line.
M · · —		Haul away.
N — ·	*	I require your spare hawser at once.
P · — — ·		Alter your course, and go to Port.
Q — — · —		The Port hawser has parted, or is stranded.
R · — ·	.	The starboard hawser has parted, or is stranded.
S — · · —		Alter your course, and go to star-board.
T — · — —	*	Turn round.
V · · · —		Is the end fast?
W · — —		Warning or alarm signal. Some-thing wrong has happened, or is likely to happen.

C inverted - — - — * Tow on: we will pay extra time.
J inverted — — — -* Slack my hawser away with a line.
Z inverted - - — — Slip my hawser.

Substitutes for the Steamer's use.

B — - - - I am going, or will go easy.
G — — - I am going, or will go full speed.
J - — — — I cannot tow any longer.
N — - I cannot comply.
T — - — — We had better turn round.
C inverted - — - — Pick up my buoy.
J inverted — — — - Haul in yours, I will tow you with one hawser.

Note.—The above messages are arranged as suitable for the Hooghly River Service; but, of course, as the requirements of the case demand, the messages can be altered and modified to the usage of any other place or Service.

391. Alphabet on the Morse System.

A B C D E F G H I J K L M

N O P Q R S T U V W X Y Z.

Answer, 'Yes,' or 'I understand.' ||||.

INSTRUCTIONS FOR USE OF FLASHING SIGNALS, FROM THE TRINITY HOUSE MANUAL, BY CAPTAIN E. P. NISBET.

1.

To commence, the lamp must always be directed towards the person addressed.

2.

To attract attention, a series of rapid short flashes or exposures should be made, and continued until the person addressed gives the sign of attention by doing the same.

3.

After making a few rapid short flashes as an acknowledgment, the Receiver must open his lamp full, and keep it so, to indicate his position until the communication is finished, when he must shut off and make the sign indicated below, showing that the message is understood.

4.

If the Receiver does not understand the message, he must shut off until the signal begins to repeat, when he must open as before and wait the completion of the message.

Duration of short	flashes	...	1 second.
" long	"	...	4 seconds.
" intervals		...	8 "

Answer, 'Yes,' or 'I understand' ... ... ||||

'No' must be spelt.

Example in Spelling by the Morse Signals.

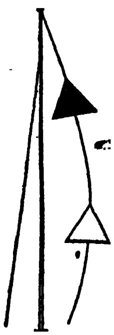
Attention sign until answered—

Want coke W,||| ..A,|| ..N,|| ..T, | . Pause of 8 seconds

C,|||| ..O, |||..K,||| ..E, |

Memorandum.—This system is applicable by using the signal whistle, a common whistle, a horn, or even the hoisting and dipping of a flag, shape, or sail.

Instructions for Spelling by the Morse System with a Flag or Symbol.



SHORT. Any **Flag or other Symbol** may be used. To be hauled down about six feet for **Short,** and twelve feet for **Long,** and back to Mast-head or

LONG. Gaff-end after each motion.

1.

To attract **Attention,** a Flag or Symbol should be hoisted to the Mast-head or Gaff-end, and hauled down and up quickly, as for **Shorts** (see Diagram), until the person addressed gives the sign of **Attention** by doing the same, and who will afterwards hoist his Flag or Symbol to the Mast-head or Gaff-end and thus wait the commencement of the communication about to be made.

2.

When the signal is completed, a few **Shorts** must be made to indicate the finish.

3.

The Receiver must then commence repeating the communication. Should, however, the message not be understood, his Flag or Symbol must be hauled down completely, as an indication of the same, and not re-hoisted to show **Attention** until the message is commenced repeating.

392. Calm, End-on, or Line-of-Wind Signals.

For use with both the new Bengal Pilots' Code and the International Code of Signals, exactly in the same manner as are the Distant Signals of the International Code of Signals used: the rules and instructions as given in the International Code for using the Distant Signals are therefore those adopted for the use of the Calm, End-on, or Line of Wind Signals, to which refer.

Example.—A wishing to signalize B (whose vessel is distant or in a line with the wind so that flags are useless) and to tell him to 'Abandon the vessel,' first runs up the 'Preparative' shape *X*, and keeps it up until B answers with the same signal; he then hauls down, and when B has dipped or hauled his down likewise, he hoists the combination for D, the first letter of the Code Signal; and when it has been duly recognized or acknowledged by B as before, and when B has again dipped the answering signal cone, telling A he has seen him haul down his first signal group, A hoists the combination for G, the second letter of the Code Signal: and so on with the last combination of shapes for the letter X, the last of the three signal letters, which, when answered as before, should be hauled down, and when B has dipped his answering cone, A should hoist the same cone as a stop, signifying the end of a complete signal; and as it too is all that A wishes to communicate, he hoists it a second time to let B know that he has finished the message.

(The above example will also serve the purpose of showing the use of the Admiralty Regulation three-Light Signals (393): which are arranged, so far as can be done, on a plan similar to this; calling the red light the X of the Pilots' Code—the cone with point upwards; the green light the Y of the Pilots' Code—the cone with point downwards; and the bright light the Z of the Pilots' Code—the drum.)

That the arrangement of the alphabetical composing table for the above may be easily remembered, it will be found that the first six, or B to H, have the cones reversed to each other; that the second six, or J to P, has both points of cones the same way; and that the third six, or Q to W, has but two shapes in a hoist.

Again, by dividing these eighteen signal groups by three, it will be found that the drum takes the lowest place in each first group; a central place in each second group (as far as P), and the top place in each third group of sets of three; also, that the upper cone in the first, third, and fifth sets, has its point upwards, whilst that in the second, fourth, and sixth set of three, has its point downwards, and that the points of cones in the first set and also in the R are away from each other, and in the second set and in the V are towards each other.

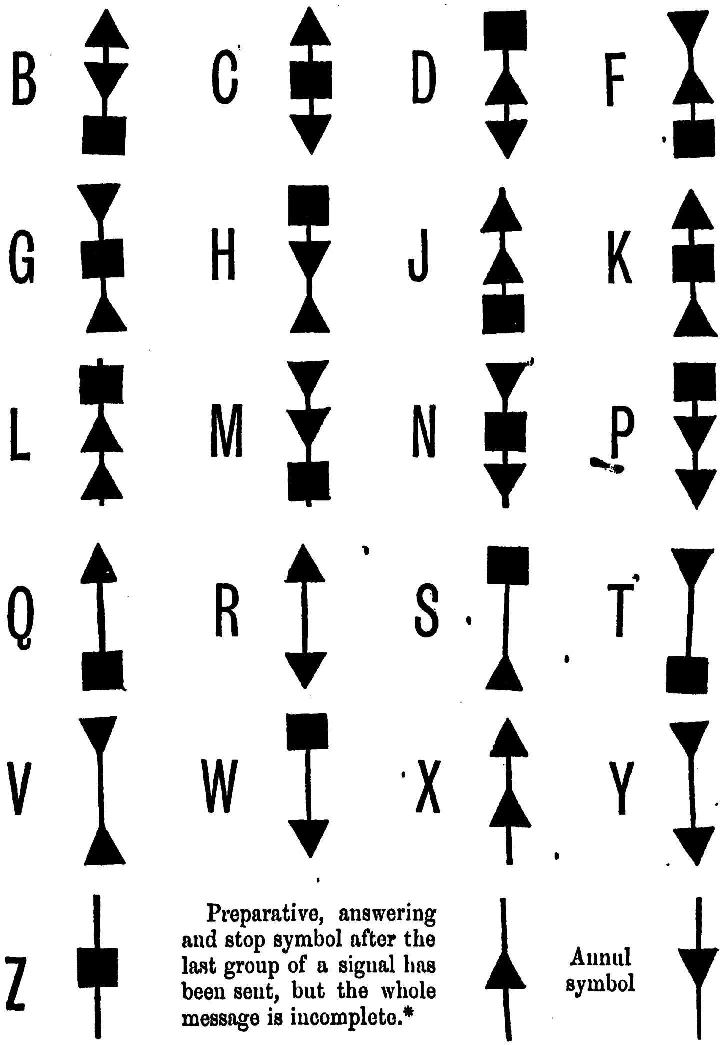
The arrangement of the last three explains itself, being the double X, the double Y and the Z, of the Pilots' Code of Signals.

The stop signal cone hoisted a second time after it has been acknowledged by the receiver of the message and kept up till it has again been acknowledged, denotes that the last group hoisted, completed or concluded the intended message, or that the signaller has finished signalling.

The annul signal denotes, cancel all that has gone before.

The shapes should be kept three feet apart.

GENERAL ALPHABETICAL TABLE FOR COMPOSING CALM OR LINE-OF-WIND SIGNALS.



* In all cases the Calm or Line-of-Wind Signals should be preceded by the 'Preparative' signal cone, kept up till answered by the same cone, and (as in all cases of signalling) no signal is to be hoisted until the answering cone is dipped.

It will be seen by the above, that there are three more letter-symbols, the X, Y, and Z, than are required for the International Code. These are the extra ones required for the *New* Bengal Pilots' Code of Signals as used on the Hooghly and its approaches.

SPECIAL SIGNIFICATIONS OF THE TWENTY-ONE CALM OR LINE-OF-WIND SIGNALS AS UNDERSTOOD BETWEEN PILOT VESSELS ONLY.

When hoisted singly and followed by the double hoist of the 'stop' signal cone, as in the case of the concluding group of any complete message from either the Pilots' or the International Code of Signals.

B. Repeat signal. Hoist in better place, or use calm or line-of-wind signals.
C. Affirmative: Yes.
D. Negative: No.
F. I am compelled to proceed into port.*
G. My vessel has met with a serious accident; please do my duties.
H. Have you seen vessel or officer (indicated).
J. A vessel in distress (as indicated).
K. I have service letter—s from Port Officer addressed "Senior Officer, Cruising Station."
L. Open service letter—s addressed "Senior Officer, Cruising Station."
M. I wish to communicate. I have important intelligence.
N. I have officers on board.
P. I have no officers on board.
Q. I have lost all my anchors.*
R. Look out and pick up the boat adrift.
S. Have you saved or picked up the boat adrift?
T. The boat adrift is saved or picked up.
V. Pilot's Ridge Light is out of position.*
W. Eastern Channel " " "*
X. Intermediate " " "*
Y. Lower Gasper " " "*
Z. Upper " " " "*

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* Port Officer to be informed by wire.

393. **Admiralty Regulation Three Light-Signals.**—For use on extraordinary and urgent occasions; and when there is no danger of the coloured lights misleading other vessels. And for this reason, these lights should only be allowed to be seen by the vessel communicated with, by some arrangement of screens. These signals are arranged to be as nearly uniform as possible with the Calm, End-on, or Line-of-Wind Signals: and are to be used, as are those signals, by the same rules as are the distant signals of the International Code: and, as the possessors of the *New* Pilots' Code of Signals will see, both of these systems can be used with that code, either apart or in conjunction with the International Code, or with the latter alone: for one of the symbols X, Y, Z, in each complete signal, will always indicate that it is the Pilots' Code that is referred to, and their absence, that it is the International Code which is being used.

As mentioned before, it is best to screen the lanterns well, and they ought to be arranged so as to be at least three feet apart: and they need not be hoisted by halliards to admit of their being seen, as they can be held by men's hands who should be properly placed as the symbols require.

General Alphabetical Table for composing Admiralty Regulation Three-Light Signals.

Signal Letters.	Arrangement of Lights.	Signal Letters.	Arrangement of Lights.
B	Red. Green. White.	M	Green, Red, White.
		N	Green, White, Red.
		P	White, Green, Red.
C	Red. White. Green.	Q	Red. Green.
D	White. Red. Green.	R	Red. White.
F	Green. Red. White.	S	Green. Red.
G	Green. White. Red.	T	Green. White.
H	White. Green. Red.	V	White. Red.
		W	White. Green.
J	Red, Green, White.	X (For Pilot's Code.)	Red, Green.
K	Red, White, Green.	Y (For Pilot's Code.)	Red, White.
L	White, Red, Green.	Z (For Pilot's Code.)	White, Red.

Preparative and stop after each complete signal ... Green, White.
Annul signal ... White, Green.

Particular attention is required to the understanding, that, in using those signals which are arranged horizontally, the above are to be the positions of the several lights as seen by the person to whom the message is being sent.

The position of the two coloured lights which would be presented by a vessel approaching end-on, *viz.*, *green*, *red*, has been purposely left out: there being just the requisite number without its use.

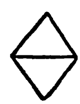
394. Hooghly River Storm Warning Signals.

STORM SIGNALS.

I.—Signals for the approaches to the Port of Calcutta.

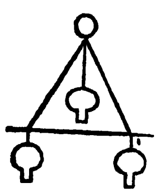
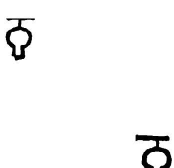
When there is bad weather in the Bay of Bengal, the following signals will be hoisted at the Flag-staff near the Lighthouse on Saugor Island at Mud Point, and at the Flag-staff, Diamond Harbour, near the Telegraph Station, on receipt of instructions telegraphed from the Meteorological Office, Calcutta :—

During Day.

Name.	Shape.	Signification.
Bad weather signal.		A single cone indicates that bad weather (such as usually precedes, but is not always followed by, a cyclone) is probably prevalent in the Bay.
Warning signal.		A black double cone indicates that the passage of a cyclone is probable, as a cyclonic vortex is believed to have been formed in the Bay. When this signal is up, pilots will not put to sea, unless in their judgment the local weather symptoms are such that this course is not imprudent; and unless the master, concurring in this opinion, distinctly takes upon himself the responsibility of going to sea, and gives the pilot a writing to that effect.

Name.	**Shape.**	**Signification.**
Danger signal.		A black drum indicates that a cylone is probably approaching. When this signal is hoisted, masters or pilots in charge of vessels are forbidden to put to sea from Saugor, or proceed down from Diamond Harbour, and should make their vessels as snug and secure as possible.

At Night.

Name.	**Shape.**	**Signification.**
Bad weather signal.		Two lights in a vertical line. Cyclonic disturbance in the Bay.
Warning signal.		Three lights in a triangle. Cyclone probable.
Danger signal.		Four lights in a square. Cyclone approaching.

The following rules for the guidance of Running Pilots are also published for general information :—

Rules 28A and 28B of the Rules for the Guidance of Running Pilots.

Rule 28*A*.—When the warning signal, as described in the notification of the 20th November, 1874, is hoisted on the Flag-staff at Saugor Island near the Lighthouse, or at Mud Point, officers in pilotage charge of vessels will not put to sea, unless in their judgment the local weather symptoms are such that this course is not imprudent; and unless the master, concurring in this opinion, distinctly takes upon himself the responsibility of going to sea, and gives the pilot a writing to that effect.

Rule 28*B*.—When the danger signal, as described in the notification of the 20th November, 1874, is hoisted on the Flag-staff at Saugor Island near the Lighthouse, or at Mud Point, officers in pilotage charge of vessels shall not put to sea, but should make the vessels under their charge as snug and secure as possible; nor should they proceed below Diamond Harbour when a black drum is hoisted at the Flag-staff at that Station.

II.—Signals for the Port of Calcutta.

The following storm-signals only are to be used within the limits of the Port of Calcutta, and are to be hoisted on the yard-arm of the Flag-staff near the Government Dockyard, Kidderpore, and on the yard-arm of the Flag-staff on the roof of the Sailors' Home, on the receipt of instructions from the Meteorological Office :—

During Day.

Name.	Shape.	Signification.
Warning signal.	*Double cone.**	Cyclone probable.
Danger signal.	*Drum.*	Cyclone approaching.

* Proposed alteration, "cone."

At Night.

Name.	Shape.	Signification.
Warning signal.	*Three lights in a triangle.**	Cyclone probable.
Danger signal.	*Four lights in a square.*†	Cyclone approaching.

395. Proposed Storm-Signals for the River Hooghly.

I. *Storm-signals to be hoisted at the Signal Stations on the Hooghly, between sunrise and sunset, during the prevalence of severe cyclonic storms in the Bay of Bengal.*

No. 1. **No. 2.** **No. 3.** **No 4.**

Day Signal No. 1. *Bad Weather Signal.* **A ball** indicates the existence of a cyclonic storm of great intensity and magnitude in the Bay of Bengal, which will either certainly cross the coast to the south of a line between Chittagong and False Point, or which may approach the Bengal coast, but is as yet too far distant to enable its line of advance to be determined.

Day Signal No. 2. *Danger Signal.* **A cone** indicates the early probable passage northward, and to the eastward of Saugor Island and west of Chittagong, of the vortex of a cyclonic storm of great intensity and magnitude. No sailing vessels, with or without steam, should put out to sea; nor should deep-laden, or slow-steaming, steam vessels go to sea. The wind at the mouth of the Hooghly will, probably, haul from north-east, through north, to north-west, &c.

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* Proposed alteration, "Three vertical lights."

† Proposed alteration, "Two vertical lights."

Day Signal No. 3. *Danger Signal.* **An inverted cone** indicates the early probable passage northward, and to the westward of Saugor Island and north of False Point, of the vortex of a cyclonic storm of great magnitude and intensity. No vessels should go to sea, and masters and pilots of vessels bound out, guided by the weather tokens and height of the barometer, should use their discretion in proceeding below Diamond Harbour or Mud Point. The wind at the mouth of the Hooghly will, probably, veer from north-east, through east, to south-east, &c.

Day Signal No. 4. *Great Danger Signal.* **A drum** indicates the approach of a cyclonic storm of great intensity and magnitude to the mouth of the Hooghly. Masters and pilots in charge of vessels are cautioned not to put to sea from Saugor, or proceed down from Diamond Harbour, and should make their vessels as snug and secure as possible.

II. *Storm-signals to be hoisted between sunrise and sunset during the prevalence of small cyclonic storm in the Bay of Bengal.*

No. 5.	No. 6.	No. 7.	No. 8.	No. 9.

Day Signal No. 5. *Bad Weather Signal.* **Two cones, the upper one inverted,** indicate the existence of a cyclonic storm of small extent in the Bay of Bengal, which will reach and cross the coast of the Bay south of a line joining Chittagong and False Point.

Day Signal No. 6. *Warning Signal.* **Two cones, the lower one inverted,** indicate the existence of

a cyclonic storm of small extent, which will, probably, or certainly, reach and cross the coast or the Bay north of a line joining Chittagong and False Point, but the path of the vortex of which cannot, as yet, be determined from the land observations.

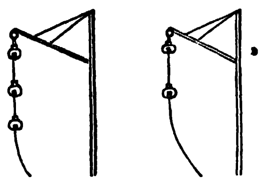
Day Signal No. 7. Warning Signal. **A ball below a cone** indicates the probable passage northwards, and to the eastward of Saugor Island and west of Chittagong, of a cyclonic storm of small extent and intensity, such as usually form in the rainy season. Vessels may proceed to sea if the height of the barometer, state of the sea and weather, are such as to lead masters and pilots to infer there is no danger. The wind at the mouth of the Hooghly will, probably, haul from north-east, through north, to north-west, &c.

Day Signal No. 8. Warning Signal. **A ball below an inverted cone** indicates the probable passage northwards, and to the westward of Saugor Island and north of False Point, of a cyclonic storm of small extent and intensity, such as usually form in the rainy season. As the wind at the mouth of the Hooghly will, probably, veer from north-east, through east, to south-east, &c., and consequently there will be a heavy swell and strong westerly set in the channel and at the Sandheads, only fast steamers in light trim should put to sea, if the weather appearances and state of the sea, &c., admit of it.

Day Signal No. 9. Danger Signal. **A ball below a drum** indicates the approach towards Saugor Roads of a cyclonic vortex of small extent, such as form during the rainy season. No vessel other than fast steamers in light trim should put to sea until the wind direction and force, state of the weather and sea, and rise of the barometer indicate that it has either broken up or passed inland: as even cyclonic storms of small extent sometimes blow fiercely and raise a high sea near their centres.

I. *Night Storm Warning Signals to be hoisted during the prevalence of cyclonic and other storms in the Bay of Bengal, at the Signal Stations on the Hooghly, between sunset and sunrise.*

No. 1. No. 2.



Night Signal No. 1. *Warning or Caution Signal.* **Three lights** exhibited on the Flag-staff at equal distances indicate the existence of a cyclonic storm in the north of the Bay.

Night Signal No. 2. *Danger Signal.* **Two lights** in a vertical line indicate the early approach of a cyclonic storm to the Bengal coast.

396. Revised Pilotage and Port-Dues for the River Hooghly and Port of Calcutta.

Resolution (Marine) the 10th July, 1881.

Upwards of ten years have elapsed since the then annually recurring deficits in the accounts of the Port of Calcutta brought prominently to the notice of Government the necessity for taking measures to establish an equilibrium between receipts and expenditure. In the year 1870-71, which showed a considerable improvement over its predecessors, the excess of expenditure over income amounted to more than three lakhs of rupees; and although the net deficit had, in 1871-72, been reduced to Rs. 1,02,000, it was still clear that increased revenue or decreased expenditure could alone enable the Port to pay its way. The high rate of the existing dues rendered the adoption of the former alternative inexpedient. It was proposed, therefore, to reduce the pilotage fees by 15 per cent., and to increase the port-dues by a corresponding amount. That this reduction might not press hardly on the pilots, the majority of whom

being remunerated by a percentage on their earnings would have suffered to the extent of about 7½ per cent., it was determined to so far lessen their number that those remaining in the service should not be injuriously affected. This scheme received the sanction of the Government of India, and the reduction in the number of pilots was effected at a cost for retiring allowances of over two lakhs of rupees.

2. Pending this change, no action was taken with regard to the fees till the 24th January, 1877, when a Resolution was recorded, from which the following is an extract:—

"The Lieutenant-Governor is therefore of opinion that the time has come for reducing the pilotage dues by 15 per cent., and making a corresponding increase in the amount of port-dues so as to secure an equilibrium between the receipts and expenditure of the Port of Calcutta. A reduction of 15 per cent. in the gross pilotage dues will enable the Government to raise the port-dues from 4 to 6 annas per ton, without imposing any additional burden upon the shipping, and, with the approval of the Government of India, which is required before any change can be made in the port-dues at present levied, this revision of existing arrangements will be carried out at once."

A technical difficulty connected with the wording of Act XII of 1875 (the Indian Ports Act) prevented the scheme from being worked in the exact manner proposed, but the object in view was gained by continuing to levy the pilotage fees at the former rate and by transferring 15 per cent. of the proceeds to the Port Fund before dividing the remainder between Government and the pilots. In June, 1880, the Committee appointed to consider the proposals for the amalgamation of the duties of the Port Officer with those of the Port Commissioners reported, that both port-dues and pilotage funds had in this way been brought into a solvent condition, and they recommended that the Government of India should, for mainly administrative reasons, be moved to amend Act XII of 1875 and to increase the maximum rate of port-dues from 4 to 6 annas per ton. The pilotage charges should, it was considered, then be formally reduced, a new

scale being framed lower than the present by 15 per cent. A similar recommendation had been made by the Committee which sat last year to investigate the accounts of Marine Expenditure, and the Port Officer was accordingly instructed to draw up a revised scale of pilotage fees in the manner suggested.

3. The Government of India has approved of this scale which is shown in the schedule to this Resolution, and will come into effect on the 1st August. In framing the scale, fractions of a rupee have, for convenience' sake, been omitted from calculation.

4. The prosperous condition of the Port Commissioners' revenues has enabled them to set aside Rs. 1,20,000 per annum as a contribution towards Port Funds, which will obviate the necessity of raising the port dues from 4 annas to 6 annas per ton as originally contemplated. The whole of the saving of 15 per cent. in pilotage will thus go to benefit the trade of the Port. The Lieutenant-Governor is glad to learn from a further communication just received from the Port Commissioners that they will be able also to make good to Port Funds the equivalent of another anna per ton from the 1st October next. The port dues will, from that date, therefore be reduced to 3 annas per ton.

APPENDIX.

RULES PUBLISHED BY THE ROYAL NATIONAL LIFE-BOAT INSTITUTION,

ON THE

Management of Open Rowing Boats in a Surf; Beaching them, &c.

1. In Rowing to Seaward.

As a general rule, speed must be given to a boat rowing against a heavy surf.

Indeed, under some circumstances, her safety will depend on the utmost possible speed being attained on meeting a sea.

For, if the sea be really heavy, and the wind blowing a hard onshore gale, it can only be by the utmost exertions of the crew that any head-way can be made. The great danger then is, that an approaching heavy sea may carry the boat away on its front, and turn it broadside on, or up-end it, either effect being immediately fatal. A boat's only chance in such a case is to obtain such way as shall enable her to pass end-on through the crest of the sea, and leave it as soon as possible behind her. Of course, if there be a rather heavy surf, but no wind, or the wind off-shore, and opposed to the surf, as is often the case, a boat might be propelled so rapidly through it, that her bow would fall more suddenly and heavily after topping the sea, than if her way had been checked; and it may therefore only be when the sea is of such magnitude, and the boat of such a character, that there may be chance of the former carrying her back before it, that full speed should be given to her.

It may also happen that, by careful management under such circumstances, a boat may be able to avoid the sea, so that each wave may break ahead of her, which may be the only chance of safety in a small boat: but if the shore be flat, and the broken

water extend to a great distance from it, this will often be impossible.

The following general rules for rowing to seaward may therefore be relied on :—

1. If sufficient command can be kept over a boat by the skill of those on board her, avoid or 'dodge' the sea if possible, so as not to meet it at the moment of its breaking or curling over.

2. Against a head gale and heavy surf, get all possible speed on a boat on the approach of every sea which cannot be avoided.

If more speed can be given to a boat than is sufficient to prevent her being carried back by a surf, her way may be checked on its approach, which will give her an easier passage over it.

2. On Running before a Broken Sea, or Surf, to the Shore.

The one great danger, when running before a broken sea, is that of *broaching-to*. To that peculiar effect of the sea so frequently destructive of human life, the utmost attention must be directed.

The cause of a boat's broaching-to, when running before a broken sea or surf, is, that her own motion being in the same direction as that of the sea, whether it be given by the force of oars or sails, or by the force of the sea itself, she opposes no resistance to it, but is carried before it. Thus, if a boat be running with her bow to the shore, and her stern to the sea, the first effect of a surf or roller, on its overtaking her, is to throw up the stern, and as a consequence to depress the bow ; if she then has sufficient inertia (which will be proportional to weight) to allow the sea to pass her, she will in succession pass through the descending, the horizontal, and the ascending positions, as the crest of the wave passes successively her stern, her midships, and her bow, in the reverse order in which the same positions occur to a boat propelled to seaward against a surf. This may be defined as the safe mode of running before a broken sea.

But if a boat, on being overtaken by a heavy surf, has not sufficient inertia to allow it to pass her, the first of the three positions above enumerated alone occurs—her stern is raised high in the air, and the wave carries the boat before it, on its

front, or unsafe side, sometimes with frightful velocity, the bow all the time being deeply immersed in the hollow of the sea, when the water, being stationary, or comparatively so, offers a resistance, whilst the crest of the sea, having the actual motion which causes it to break, forces onward the stern, or rear end of the boat.

A boat will, in this position, sometimes aided by careful oar-steerage, run a considerable distance until the wave has broken and expended itself. But it will often happen, that if the bow be low, it will be driven under water, when the buoyancy being lost forward, whilst the sea presses on the stern, the boat will be thrown (as it is termed) end over end; or if the bow be high, or it be protected, as in most life-boats, by a bow air chamber, so that it does not become submerged, that the resistance forward, acting on one bow, will slightly turn the boat's head, and the force of the surf being transferred to the opposite quarter, she will in a moment be turned round broadside by the sea and be thrown by it on her beam-ends, or altogether capsized. It is in this manner that most boats are upset in a surf, especially on flat coasts, and in this way many lives are annually lost amongst merchant seamen when attempting to land, after being compelled to desert their vessels.

Hence it follows, that the management of a boat, when landing through a heavy surf, must, as far as possible, be assimilated to that when proceeding to seaward against one, at least so far as to stop her progress shoreward at the moment of being overtaken by a heavy sea, and thus enabling it to pass her. There are different ways of effecting this object :—

1. By turning a boat's head to the sea before entering the broken water, and then backing in stern foremost, pulling a few strokes ahead to meet each heavy sea, and then again backing astern. If a sea be really heavy and a boat small, this plan will be generally the safest, as a boat can be kept more under command when the full force of the oars can be used against a heavy surf, than by backing them only.

2. If rowing to shore with the stern to seaward, by backing all the oars on the approach of a heavy sea, and rowing ahead again as soon as it has passed to the bow of the boat, thus rowing in on the back of the wave; or, as is practised in some life-boats,

placing the after-oarsmen, with their faces forward, and making them row back at each sea on its approach.

3. If rowed in bow foremost, by towing astern a pig of ballast or large stone, or a large basket, or canvas bag termed a 'drogue' or drag, made for the purpose, the object of each being to hold the boat's stern back, and prevent her being turned broadside to the sea or broaching-to.

A boat's sail bent to a yard, and towed astern loosed, the yard being attached to a line capable of being veered, hauled, or let go will act as a drogue, and tend much to break the force of the sea immediately astern of the boat.

Heavy weights should be kept out of the extreme ends of a boat; but when rowing before a heavy sea, the best trim is deepest by the stern.

A boat should be steered by an oar over the stern, or on one-quarter when running before a sea, as the rudder will then at times be of no use. If the rudder be shipped, it should be kept amidships on a sea breaking over the stern.

The following rules may, therefore, be depended on when running before, or attempting to land, through a heavy surf or broken water:—

1. As far as possible, avoid each sea by placing the boat where the sea will break ahead or astern of her.

2. If the sea be very heavy, or if the boat be very small, and especially if she have a square stern, bring her bow round to seaward and back her in, rowing ahead against each heavy surf that cannot be avoided sufficiently to allow it to pass the boat.

3. If it be considered safe to proceed to the shore bow foremost, back the oars against each sea on its approach, so as to stop the boat's way through the water as far as possible, and if there is a drogue, or anything in the boat that may be used as one, tow it astern to aid in keeping the boat end on to the sea, which is the chief object in view.

4. Bring the principal weights in the boat towards the end, that is to seaward, but not to the extreme end.

5. If a boat, worked by sails or oars, be running under sail for the land through a heavy sea, her crew should, under all circumstances, unless the beach be quite steep, take down her

masts and sails before entering the broken water, and take her to land under oars alone, as above described.

If she have sails only, her sails should be much reduced, a half-lowered foresail or other small head-sail being sufficient.

3. Beaching or Landing through a Surf.

The running before a surf or broken sea, and the beaching or landing of a boat, are two distinct operations; the management of boats, as above recommended, has exclusive reference to running before a surf where the shore is so flat that the broken water extends to some distance from the beach. Thus, on a very steep beach, the first heavy fall of broken water will be on the beach itself, whilst on some very flat shores there will be broken water as far as the eye can reach, sometimes extending to even four or five miles from the land. The outermost line of broken water, on a flat shore, where the waves break in three and four fathoms water, is the heaviest, and therefore the most dangerous, and when it has been passed through in safety, the danger lessens as the water shoals, until, on nearing the land, its force is spent and its power harmless. As the character of the sea is quite different on steep and flat shores, so is the customary management of boats on landing different in the two situations. On the flat shore, whether a boat be run or backed in, she is kept straight before or end to the sea until she is fairly aground, when each surf takes her further in as it overtakes her, aided by the crew, who will then generally jump out to lighten her, and drag her in by her sides. As above stated, sail will, in this case, have been previously taken in if set, and the boat will have been rowed or backed in by oars alone.

On the other hand, on the *steep* beach, it is the general practice, in a boat of any size, to retain speed right on to the beach, and in the act of landing, whether under oars or sail, to turn the boat's bow half round towards the direction from which the surf is running, so that she may be thrown on her broadside up the beach, when abundance of help is usually at hand to haul her as quickly as possible out of the reach of the sea. In such situations, we believe, it is nowhere the practice to back a boat in stern foremost under oars, but to row in under full speed as above described.

BOARDING.

(From Bedford's Sailor's Pocket Book.)

Boarding a Wreck, or a Vessel under Sail, or at Anchor in a Heavy Sea.

The circumstances under which life-boats, or other boats, have to board vessels, whether stranded or at anchor, or underweigh, are so various, that it would be impossible to draw up any general rule for guidance. Nearly everything must depend on the skill, judgment, and presence of mind of the coxswain, or officer in charge of the boat, who will often have those qualities taxed to the utmost, as undoubtedly the operation of boarding a vessel in a heavy sea or surf is frequently one of extreme danger.

It will be scarcely necessary to state that, whenever practicable, a vessel, whether stranded or afloat, should be boarded to leeward, as the principal danger to be guarded against must be the violent collision of the boat against the vessel; or her swamping or upsetting by the rebound of the sea: or by its regular direction on coming in contact with the vessel's side; and the greater violence of the sea on the windward side is much more likely to cause such accidents. The danger must of course also be still further increased when the vessel is aground and the sea breaking over her. The chief danger to be apprehended on boarding a stranded vessel on the lee side, if broadside to the sea, is the falling of the masts; or if they have been previously carried away, the damage or destruction of the boat amongst the floating spars and gear alongside. It may therefore, under such circumstances, be often necessary to take a wrecked crew into a life-boat from the bow or stern; otherwise a rowing boat proceeding from a lee shore to a wreck, by keeping under the vessel's lee, may use her as a breakwater, and thus go off in comparatively smooth water. This is accordingly the usual practice in the rowing life-boats. The larger sailing life-boats, which go off to wrecks on outlying shoals, are, however, usually anchored to windward of stranded vessels, and then veered down to 100 or 150 fathoms of cable, until near enough to throw a line on board.

The greatest care, under these circumstances, has of course to be taken to prevent actual contact between the boat and the ship.

In every case of boarding a wreck or vessel at sea, it is important that the line by which a boat is made fast to the vessel should be of sufficient length to allow of her rising and falling freely with the sea; and every rope should be kept in hand ready to cut or slip it in a moment, if necessary.

Before going alongside a vessel, underweigh and hove to, observe if she have head or sternway, and in any case get the masts down before closing her. Wait until the ship has gathered headway, and then go alongside.

Do not shove off during sternway, else the ship, in setting to leeward and falling off, may bury the boat under her bows, or with her stem and dolphin striker cut the boat down.

In being towed by a vessel, if alongside, contrive to have the rope from as far forward as possible, so as to avoid riding at a short stay: never make it fast, but toggle it with a stretcher through the aftermost of the foremost sling bolts, so as to be able to slip in an instant.

In being towed astern, the closer the better.

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